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THE STUDENT'S HANDBOOK

OF

FORENSIC MEDICINE.

MURRAY AND GIBB, EDINBURGH,
PRINTERS TO HER MAJESTY'S STATIONERY OFFICE.

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THE STUDENT'S HANDBOOK

OF

FORENSIC MEDICINE

AND

MEDICAL POLICE.

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THE STUDENT'S HANDBOOK

OF

FORENSIC MEDICINE.

INTRODUCTION.

TO that branch of medical knowledge which is engaged in the solution of every question connected with the conservation of the species and the administration of justice, the term Forensic or Legal Medicine has been applied. It also forms the Medical Jurisprudence of some writers.

In order to be as concise and as plain as possible, it will be necessary to discuss some matters of general application, before considering others which have a more special interest. These will therefore be considered under the following heads.

MEDICAL EVIDENCE GENERALLY.

A. *Documentary.* **B.** *Oral.* **C.** *Experimental.*

A. *DOCUMENTARY.*

Under this head are included Medical Reports, Written Opinions, and Medical Certificates.

The Medical Certificate.—There is no particular legal form prescribed in England for these documents. A statement signed by a registered medical practitioner, distinctly stating the nature of the illness of A. or B., is all that is necessary as far as the law is concerned.

'A certificate of bad health by a physician or surgeon must bear to be on soul and conscience.' . . . 'In cases of homicide, and other crimes against the person, medical certificates produced respecting the nature of the injuries must be verified on oath by the medical persons who granted them.'—*Dict. Scot. Law.*

It cannot be too strongly urged on medical men the necessity of simplicity in the arrangement and in the wording of their reports. 'A medical witness will do well to remember also, that copies of his report and depositions, either before a coroner or magistrate, are usually placed in the hands of counsel as well as of the court; and that his evidence, as it is given at the trial, is compared word for word with that which has already been put on record.' All hearsay statements and irrelevant matter should not be inserted in a report. All technical words or phrases should be as much as possible avoided; and where they are absolutely necessary, they should be briefly explained. The use of superlatives is also very objectionable, as it partakes somewhat of exaggeration. All notes of a case should be made at the time of the inspection or immediately afterwards. From these notes a witness may refresh his memory, but they are not accepted in its place. They should contain a plain statement of the facts; and to render them admissible as evidence, they must be taken *at the time*, and duly attested.

A medical report consists of two parts—the *Minute of the Examination*, and the *Reasoned Opinion* on the first portion of the report. In the case where the report is made by two or more persons appointed for the purpose, the latter portion is written in the plural, and signed by each of the parties certifying.

The following is an outline of a medical report, which may be more or less modified to suit the requirements of the case :—

FORM OF MEDICAL REPORT.

A. Minute of the Examination.

1. External Inspection.

a. General condition of the body.
1. *Well or ill nourished.*
2. *General colour.*
3. *Marks and scars.*
4. *Products of disease—ulcers, hernia, etc.*
5. *Injuries.*

Caution.—There may be no external marks of injury, and yet death may be due to violence. Extreme difficulty in deciding if injury be inflicted before or after death.

b. Height.

Determined by measurement.

c. Age.

This can only be approximately guessed.

d. Sex.

This is, of course, only difficult when putrefaction is far advanced. Hair found only on the MONS VENERIS *or* PUBES *is characteristic of the female, but if it extends upwards on the abdomen, equally so of the male. No sex can be distinguished in the embryo before the third month of intra-uterine life.*

e. Colour of the eyes.

Difficult of determination. Why?
1. *Disagreement of observers.*
2. *Presence of putrefaction.*

f. Colour of the hair.

This is necessary, in order to compare hair of deceased with that found on suspected party.

g. Position of the tongue.
Normal, abnormal, injured or uninjured.

h. Condition and number of the teeth.
1. *Complete.*
2. *Incomplete.*
3. *Any peculiarity as regards size or form, in order to compare with mark or bite on suspected party, etc.*

i. Signs of death.
Presence or absence of rigor mortis *or supervening putrefaction.*

j. Condition and contents of the hands and nails.
1. *In the drowned—weeds, sand, and signs of long immersion.*
2. *In those shot—scorching or blackening of the hand from powder, or injury from recoil of the weapon. Is weapon grasped firmly in the hand?*

k. Condition of the natural openings of the body—nose, mouth, etc.
1. *Presence of sand or weeds in mouth of those found in the water.*
2. *Presence of marks of corrosive poisons.*
3. *Presence or absence of the signs of virginity, or of recent injury about the parts.*

l. Condition of the neck.
1. *Presence of marks of strangulation.*
2. *Condition of the upper cervical vertibræ.*
3. *Dangers to be avoided in determining fracture or dislocation of the cervical vertibræ.*
Great mobility of neck, sometimes present, not due to injury of the bones.

2. *Internal Inspection.*

A. Cranial Cavity.

a. Condition of the bones of the skull.

b. Condition of the membranes and sinuses of the brain.
c. Condition and appearance of the brain substance.
d. Contents of the lateral ventricles.

B. Thoracic Cavity.

a. Position of the organs on opening the chest.
b. Condition of the heart, large blood-vessels, and pericardium.
c. Condition of the lungs, larynx, trachea, and gullet.

C. Abdominal Cavity.

a. Position of the abdominal organs.
b. Healthy or diseased condition of the liver, spleen, stomach, bladder, and kidneys.
c. Contents of the stomach and bladder.

Should it be necessary to remove the stomach and intestines, a ligature should be placed at the cardiac extremity of the stomach, and another on the sigmoid flexure of the colon, and then a division beyond the ligatures will permit of the entire removal of the bowels.

d. Condition of the blood-vessels.

B. The Reasoned Opinion.

In this portion of the report the inspectors state the nature of the conclusions at which they have arrived, and their reasons.

B. *ORAL.*

A medical man may be called as a *common witness*, or as an *expert* or skilled witness. In the *first* case he has only to state, as any other witness might do, the facts that have fallen under his observation; in the *second* he has to interpret the facts he has himself

observed, or to give his opinion on facts noticed by others. A medical witness should remember that he is not retained for a party, but in the cause of justice. He must therefore be candid in his manner and simple in his language.

The advice given by Sir W. Blizard may not be out of place here: 'Be the plainest men in the world in a court of justice; never harbour a thought that, if you do not appear positive, you must appear little and mean for ever after: many old practitioners have erred in this respect. Give your evidence in as concise, plain, and yet clear manner as possible; be intelligent, candid, open, and just, never aiming at appearing unnecessarily scientific. State all the sources by which you have gained your information. If you can, make your evidence a self-evident truth; thus, though the court may at the time have too good or too mean an opinion of your judgment, yet they must deem you an honest man. Never, then, be dogmatic, or set yourself up for judge and jury; take no side whatever; be impartial, and you will be honest. In courts of judicature you will frequently hear the counsellors complain when a surgeon gives his opinion with any the least kind of doubt—that he does not speak clearly; but if he is loud and positive, if he is technical and dogmatic, then he is allowed to be clear and right. I am sorry to have to observe that this is too frequently the case.'

SUBPŒNA.—Except upon a subpœna, a medical man *is not* bound to attend as witness at a trial; and then it should be served a reasonable time before the trial, in order that he may make proper arrangements for the carrying on of his business during his absence. In civil cases his reasonable expenses should be tendered to him at the time the subpœna is served, or within a reasonable time of the trial; and he may refuse to give evidence unless his charges are paid, provided his objection be stated *before he has been sworn.*

No tender of fees is necessary in criminal cases, 'except in the case of witnesses living in one distinct part of the United Kingdom being required to attend subpœnas directing their attendance in another, who are not liable to punishment for disobedience of the process, unless at the time of service a reasonable and sufficient sum of money to defray their expenses in coming, attending, and returning have been tendered to them.' When summoned to two cases, one civil, the other criminal, the witness must attend the criminal; when both cases are the same, the one to which he first received the subpœna.

C. *EXPERIMENTAL.*

Under this head will be treated the examination of the living and of the dead, identity, real and apparent death, cause of death, and experiments with the weapons alleged to have been used; exhumations, and autopsies.

EXAMINATION OF THE LIVING.

With regard to the identification of the living, the opinion of a medical man is seldom sought. It is only in cases where questions have arisen as to the presence and character of certain marks on the body, or of doubtful sex, that a medical man may be consulted. The marks which most frequently give rise to differences of opinion are *nævi materni, scars,* and *tattoo marks.* In cases of doubtful sex the male organs may resemble the female, the female the male, or they may be blended together in about equal proportions.

The following questions may be put to the medical expert:—

a. Do scars ever disappear?
b. Can the age of a scar be definitely stated?
c. Can tattooing, when once present, ever become thoroughly effaced by time?

In reply to the two first questions, I shall quote the words of the late Professor Casper: '*Consequently the scars occasioned by actual loss of substance, or by a wound healed by granulation, never disappear, and are always to be seen upon the body. But the scars of leech bites, or lancet wounds, or of cupping instruments, may disappear after a lapse of time that cannot be more distinctly specified, and may therefore cease to be visible upon the body. It is extremely difficult or impossible to give any certain or positive opinion as to the age of a scar.*' My own experience bears out the above statement; for I have a patient who informs me that she was repeatedly bled in *both* arms, yet I can only detect, after the most careful examination, the marks in one arm, and these are by no means very distinct.

With regard to the last question, the subject of the disappearance of tattoo marks has given rise to considerable discussion in the great Tichborne case recently tried at Bar. On this subject the experiments of Hutin, Tardieu, and Casper appear to point to the fact 'that tattoo marks may become perfectly effaced during life,' but that after death the colouring matter with which the marks were made may be found in the lymphatic glands. Hutin found that, in 506 men who had been formerly tattooed, the marks had disappeared from 47 of the number. On this subject see also Tardieu's paper in the *Annales de Hygiène publique* (Jan. 1855, p. 171 et seq.).

As a means of disguise the hair may be dyed, or the colour may be changed from dark to light.

There is one more question bearing on this subject, viz:—

What amount of light is necessary for the purpose of identification?

In one well-authenticated case, a lady was enabled to identify the person of a thief by the light emitted by a momentary flash of lightning; and it also appears probable that the flash of light from a gun or pistol

may be of sufficient intensity for the purposes of identification.

EXAMINATION OF PERSONS FOUND DEAD.

The Object of such Examination.

1. To answer the question, Who is it?
   - As an aid to diagnosis, it is important to remember that certain trades leave marks by which those engaged in them may be identified.
   - Thus, in shoemakers there may be more or less depression of the lower portion of sternum, due to the constant pressure of the last against the bone.
   - In coachmen, corns may be formed between the thumb and index finger, and between the index and the second finger of the left hand, from the pressure of the reins.
   - In stonemasons, from the constant action of picking up the bricks, flattening of the tip of the thumb and index finger of left hand is not uncommon.
   - The finger-ends of turners and coppersmiths are also more or less flattened; in the latter a deposit of the metal may take place.

2. In the case of an infant found dead, it may be necessary to determine whether it was born alive, and also whether it had reached that period when it could maintain an existence apart from its mother.

3. To determine the time which may have elapsed since death.

4. To ascertain the cause or causes of death.

Modes of Sudden Death.

Syncope. *Asphyxia.* *Coma.*

SYNCOPE, from *συγκοπτω, I strike down.* Arrest of the action of the heart.

This condition may be brought about by

1. Deficiency of blood due to hemorrhage.
2. Effect of certain diseases and poisons.

Post-mortem Signs.—The cavities of the heart contain a normal quantity of blood. The blood is simply arrested in its course; blood is therefore found in the large veins and in the arteries. The brain and the lungs are not engorged with blood.

ASPHYXIA, from ἀ priv. et σφυξις, *pulse*. Apnœa is the better term—ἀ priv. et πνεω, *I respire*. Asphyxia, or death from defect in the quality of the blood, is brought about when any impediment is placed on the healthy action of the lungs.

Causes.—1. Certain diseases affecting the lungs—*pneumonia, bronchitis, etc. etc.*

2. Mechanical obstruction to respiration—*strangulation, drowning, hanging, etc.*

Post-mortem Signs.—Engorgement of the pulmonary artery, the right cavities of the heart, and *venæ cavæ*, is present; but on the left side of the heart, the cavities, together with the aorta, are either empty or contain but little blood. It must be remembered, however, that cases of asphyxia do sometimes occur where the cavities on each side of the heart are empty, or nearly so. If also the obstruction to respiration be imperfect, the circulation may be continued for some time, congestion of one or more of the internal organs being the result.

COMA.—Death in this case is due to some cerebral mischief.

Cause.—Apoplexy, fracture of the cranial bones, compression or destruction of the brain substance.

Post-mortem Signs.—Congestion of the membranes and substance of the brain, and of the lungs. The cavities of the heart, especially those of the right, contain more or less blood.

Real or Apparent Death.

It will be unnecessary here to discuss any of the

theories put forth with regard to cases of apparent death or prolonged trance, but simply to note in the order of their occurrence the phenomena which attend real death.

Real Death.

1. Entire cessation of respiration and circulation; no murmur heard on auscultation.

2. The lustre of the eye is lost immediately after death.

3. The most powerful stimulus applied to the body does not cause any *reaction.* The muscles *may*, however, be made to contract shortly after death by the stimulus of a slight blow, or by galvanism.

4. The surface of the body becomes of an ashy-white colour.

Exceptions.

a. Persons of florid complexions retain this for some time after death.

b. The red or livid edges of ulcers.

c. Blue, black, or red tattoo marks, if not effaced during life, do not disappear.

Ecchymoses retain the hue they had at the time of death.

d. An 'icteric' coloration existing at death never becomes white. Death from jaundice.

e. A rosy tint of the skin described by Devergie on those poisoned by carbonic acid.

5. The temperature of the body at the time of death is retained for some time. *Cooling will depend on the medium in which the body is placed.*

Average internal temperature of body during life, 98° *to* 100° *F.*

a. Fat persons retain the heat longer than lean ones; adults longer than children or old persons.

Bodies cool by

1. *Radiation.*
2. *Conduction.*
3. *Convection.*

b. Bodies immersed in water cool more rapidly than in air.

This fact may be of importance in determining survivorship in a case of drowning.

c. Bodies in bed and covered by the clothes, or in cesspools and in dung-heaps, cool less rapidly than when exposed.

d. Persons killed by lightning keep longer warm than others (?).

e. Death by suffocation retards the process of cooling.

f. The body may be cold externally, but possess a considerable amount of heat when the internal organs are exposed. Persons who have died of cholera, yellow fever, or suddenly of some acute disease — rheumatism — may retain for some hours a considerable amount of heat. It has even been asserted, that in some diseases —cholera—there is un increase of temperature soon after death.

g. Most bodies under ordinary circumstances are, as a rule, quite cold in from eight to twelve hours after death.

6. Relaxation more or less general of the muscular system takes place.

If the above signs are alone present, death must have taken place in from ten to twelve hours at the longest (Casper).

7. Want of elasticity in the eyeball.

This condition invariably occurs in from twelve to eighteen hours after death.

8. Flattening of the muscles of those parts on which the body rests, due probably to loss of vital turgidity.

9. Hypostases, due to the gravitation of the blood to the most dependent parts of the body. They begin to form in from eight to twelve hours, and increase in size till putrefaction sets in.

10. Cadaveric rigidity.

Cadaveric rigidity, or *rigor mortis,* in every case

precedes putrefaction, and consists in a shortening and thickening of certain muscles, chiefly the flexor and adductor muscles of the extremities, and also the elevators of the lower jaw.

This condition commences in the muscles of the back of the neck and lower jaw, and then passes into the muscles of the face, part of the neck, chest, and upper extremities, and then, last of all, into those of the lower extremities. It in most cases passes off in the same order, the body becoming quite flaccid, the *rigor mortis* never returning. These phenomena occur whilst the body is cooling.

Cadaveric rigidity generally supervenes in from eight to twenty hours after death; but in some cases it comes on earlier, and may continue from four to nine days. After narcotic poisoning, the *rigor mortis* is said either not to occur at all, or to pass off so rapidly as to be entirely absent before the body is inspected. In poisoning by carbonic acid the *rigor mortis* is slight, whilst in cases of strychnia poisoning it soon supervenes, but lasts a *long* time. In infants and young children, cadaveric rigidity is feeble, and soon disappears. A low temperature at the time of death favours the duration of *post-mortem* rigidity; and this is still more marked if, with the low temperature, the person be in a state of intoxication at the time of death. Putrefactive discoloration of the body may co-exist with a prolongation of the *rigor mortis.*

From the moment of death till the time when putrefaction sets in, the muscular structures of the body may be said to pass through three stages.

1. *Muscular Irritability.*

The muscles flaccid, but still possessing the power of contractility on the application of certain stimuli. Parts contracted during the act of dying, as the muscles of the hand grasping a knife or other weapon, may continue so for some time after death.

2. *Cadaveric rigidity.*

A state of rigidity, the power of contractility absent.

3. *Commencement of putrefaction and chemical change.*

Relaxation again present; all power of contraction lost, not to be regained.

Cadaveric rigidity is purely muscular, and is not dependent on the nervous system.

CADAVERIC RIGIDITY.

Table showing the principal points to be noted in the period of accession of this condition, and the causes which retard or hasten its appearance, or modify its duration :—

In what does it consist?	In a shortening and thickening of the muscles, particularly the flexors and adductors of the extremities, and elevators of the lower jaw.
Period of invasion.	Generally in from eight to twenty hours after death. It has been known, however, to supervene within three minutes of death, or it may be delayed for sixteen or seventeen hours.
Period of duration.	From one to nine days. Three weeks (Taylor, p. 13).
Order in which the muscles are affected.	Back of neck and lower jaw, muscles of the face, front of the neck, chest, upper extremities, and then the lower extremities.
Order in which it disappears.	Back of neck, lower jaw, etc., following the course of its accession.
Effects of exposure to cold.	Prolonged by dry cold air, and by cold water.
Effects of enfeebling disease prior to death.	Rapid in its invasion, and passing off rapidly.
Effects of a robust frame at period of death.	The accession may be prolonged; but, other things being equal, it is more strongly manifested, and continues longer.

Effects of violent exercise prior to death.	Rapidly supervenes, and rapidly disappears.
Effects of poison.	Poisons which cause violent contractions for some time prior to death—strychnia, etc.—influence the rapid invasion of the *rigor mortis*, its short duration, rapidly followed by putrefaction. Where death in poisoning by strychnia is almost instantaneous, with a short convulsive stage, the *rigor mortis* comes on *rapidly*, and remains a *long* time.

CUTANEOUS HYPOSTASIS.

1. *Meaning of the expression.*

The gravitation of the blood in the capillaries after death, in obedience to the laws of inert matter.

2. *On what parts of the body usually seen?*

On the most dependent parts of the body; on the whole of the back of the body, if the body be supine.

3. *At what period after death first observed?*

In from eight to twelve hours, gradually extending in size till putrefaction sets in.

4. *Whether or not affected by death from hemorrhage?*

Formed after every kind of death, even after death due to hemorrhage.

5. *With what result of external violence sometimes confounded?*

Liable to be confounded with ecchymosis, the result of injury.

6. *How distinguished from this?*

Effused or coagulated blood is found when an incision is made in a true ecchymosis, however small. Only a few bloody points seen on incision into a *post-mortem* stain or true hypostasis, and it is never raised above the surface, as ecchymoses sometimes are.

Determination of the Period that has intervened between the Death and the Inspection.

The subject under consideration is beset with difficulties, and its elucidation will require the greatest care on the part of the medical expert. In forming an opinion as to the period that may have elapsed from death to the time that the inspection is made, the following circumstances must be taken into consideration :—

1. Age.
2. Air.
   a. Moving. *b.* At rest.
3. Moisture.
4. Warmth.
   Temperature of the surrounding atmosphere.
5. Nature of the supposed cause of death.
6. Presence or absence of the *rigor mortis.*

The following table, suggested by Devergie, and adopted by Taylor, may be of use in aiding the expert in forming his opinion. It is divided into four stages or periods, the last being that in which putrefaction commences :—

First period.	*From a few minutes to twenty hours after death.* Animal heat more or less present, but seldom continuing longer than ten or twelve hours. Muscles contract on the application of galvanic stimuli, and in the earlier stage to blows.
Second period.	*From ten hours to three days.* Body quite cold, and *rigor mortis* well marked ; muscles do not contract on the application of stimuli. The age, mode of death, and other collateral circumstances must, more or less, be taken into consideration before an opinion can be given.
Third period.	*From three to eight days.* The body is quite cold, and cadaveric rigidity has passed off. The muscles no longer respond to any galvanic or mechanical stimuli. This stage is modified and somewhat shortened in summer.

Fourth period.	*From six to twelve days.* Commencement of putrefaction. Putrefaction may, however, take place on the first or second day after death; so that, as before stated, care must be taken before any positive decision can be given.

PUTREFACTION.

Internal conditions which modify putrefaction.

1. AGE.
2. SEX.
3. CONDITION OF THE BODY.
   a. *Constitutional peculiarity.*
   b. *State of the body.*
4. KIND OF DEATH.
   a. *The result of disease.*
   b. *The result of poison.*

External conditions which modify putrefaction.

1. AIR.
2. MOISTURE.
3. WARMTH.

Internal Conditions which modify Putrefaction.

1. AGE.—The bodies of young children, other things being equal, are said to putrefy rapidly. It should be remembered, however, that clothing possesses considerable power in retarding putrefaction, and that, in the hurry and anxiety to get rid of the infants, they are oftener exposed naked than clothed, which may in some measure account for their more rapid decomposition.

2. SEX.—Sex, it would appear, has little or no influence either to retard or hasten putrefaction; but it has been remarked that females dying during or soon after child-birth, irrespectively of the cause of death, do putrefy most rapidly.

3. Condition of the Body.

a. Constitutional Peculiarity.—It is generally admitted that persons of the same age and sex, dying similar deaths, and subjected to like conditions as to exposure to the air and interment in the same soil, exhibit marked differences as regards the accession and rapidity of putrefaction. The explanation may be difficult, but the fact still remains.

b. State of the Body.—Fat and flabby corpses putrefy more rapidly than the lean and emaciated. Hence old people, who are generally thin, keep fresh for a comparatively long time. Bodies also which are much mutilated rapidly decompose, decomposition setting in first at the part injured. In examining wounds and bruises said to have been inflicted during life, it is well to remember that the tendency of putrefaction is to make them appear more severe.

4. Kind of Death :—*a. Effect of Disease. b. Effect of Poisons.*

a. Effect of Disease.—Healthy persons dying suddenly, other things being equal, are said to decompose more slowly than those who have died from exhausting diseases, as in the case of typhoid, phthisis, dropsy following organic disease, or of those diseases attended with more or less putridity of the fluids.

b. Effect of Poisons.—Putrefaction rapidly supervenes in those who have died suffocated by smoke, by carbonic oxide, and by sulphuretted hydrogen. Narcotic poisoning is stated to accelerate this condition; but poisoning by phosphorus, alcoholic blood-poisoning, and in cases of death from sulphuric acid, the putrefactive changes are greatly retarded. The manner in which death takes place from the action of the poison greatly advances or retards putrefaction. Thus, in the case of poisoning by strychnia, it is found that when death has occurred rapidly, without much muscular exhaustion, putrefaction sets in slowly; but that when the muscular irritability has been by successive fits

greatly exhausted, the contrary is the result. Arsenic, chloride of zinc, and antimony, are reputed to possess antiseptic properties.

External Conditions which modify Putrefaction.

1. AIR.—Exposure in the open air has a marked effect in promoting putrefaction; but garments fitting close to the body, and thus excluding air, have a contrary effect. Dry air, or air in motion, by assisting evaporation from the corpse, acts as a preservative. The composition of the soil in which the body is placed has also a more or less modifying effect. In light porous soil, allowing of the free ingress of air, decomposition is more rapid than in close compact soil, as clay; but in this we have to contend with another agent, moisture, which more or less counteracts the protective virtue of the closer earth.

2. MOISTURE.—Putrefaction cannot proceed without moisture. The body, however, contains sufficient water to enable this process to commence spontaneously. Organic substances artificially deprived of water do not putrefy. Cold and heat possess marked antiseptic properties, the former by freezing the fluids in the body, the latter by drying them up.

3. WARMTH.—A temperature between 70° and 100° F. is found most favourable to decomposition. The effect of cold is shown by the fact that a body immersed in water during winter, at a temperature between 36° and 45° F., may be so well preserved as to present, ten or twelve days after death, well-marked signs of violence, which would in summer have been utterly obliterated in five or seven days. The preservative influence of cold water will, however, depend greatly on the depth at which the body has been submerged. Bodies so submerged, and then exposed to the air, putrefy with such rapidity, that exposure for one day is said to work a greater change

than three or four days' longer retention of the body in the water. As an instance of the preservative power of cold, may be mentioned the mammoth found in Siberia embedded in a block of ice.

THE PHENOMENA OF PUTRESCENCE IN THEIR CHRONOLOGICAL ORDER.

I.—External.

One to Three Days.—Greenish coloration of the abdominal walls. Odour of putrescence is gradually developed, and concurrently with this the eyeball becomes soft, and yielding to pressure.

Three to Five Days.—The green colour of a deeper shade has now spread over the abdomen, extending also to the genital organs. Patches of this green coloration also make their appearance somewhat irregularly on other parts of the body, such as the neck, back, chest, and lower extremities. A dark reddish frothy fluid about this time wells up from the mouth.

Eight to Ten Days.—The patches of green colour have now coalesced, so that the whole body is discoloured. On some parts of the body the colour is of a reddish green, due to the presence of decomposed blood in the cellular tissue. The abdomen is now distended with gases, the products of decomposition. The colour of the eyes has not disappeared, but the cornea has fallen in. Relaxation of the *sphincter ani* takes place, and the superficial veins appear like reddish-brown cords. The nails still remain firm.

Fourteen to Twenty Days.—The colour of the surface is now bright green, with here and there patches of a blood and brown colour. The epidermal layer of the skin is raised in bullæ of varying size; in some places the skin being more or less stripped off. The nails are detached, and can be easily removed. The

hair can be pulled from the scalp with ease. The body is now greatly distended with gases, and the features cannot be recognised owing to the swollen condition of the face. The body is generally covered with vermin. In determining the time at which death occurred, it will be necessary to take into consideration the season of the year, as it is found that an advanced stage of decomposition may be present in from eight to ten days, with the thermometer ranging between 68° and 77° F., which in winter, with a temperature of from 32° to 50°, would require twenty to thirty days.

'*Bodies green from putridity, blown up and excoriated, at the expiry of one month, or from three to five months after death* (*cæt. par.*), *cannot with any certainty be distinguished from one another*' (CASPER).

Three to Six Months.—During the above period the stage of collequative putrefaction has set in. The thoracic and abdominal cavities, due to the increased formation of gas, have burst. The bones of the cranium have more or less separated, allowing the brain to escape. The soft parts are more or less absorbed, and no recognition of the features is possible. The sex can only be positively made out by the presence of a uterus, or by the peculiar growth of hair on the pubes, which in woman only covers the pubes, but in man extends upwards to the navel.

Saponification.—Bodies exposed to the action of water, or buried in damp, moist soil, are apt to undergo certain changes, in the course of which they become saponified, and the formation of a substance known as *adipocire* is the result.

Adipocire—adeps, lard, and *cera,* wax—is chiefly composed of margarate of ammonia, together with lime, oxide of iron, potash, certain fatty acids, and a yellow-coloured odorous matter. The melting point is 126·5° F. Adipocire has a fatty, unctuous feel, is either pure white or of a pale yellowish colour,

and with the odour of decayed cheese. The formation of this substance 'to any considerable extent is not likely to occur in less than three to four months in water, or six months in moist earth, though its commencement may take place at a much earlier period.'

To explain the formation of adipocire, it has been supposed to be due to the decomposition of the muscular structures of the body, by which hydrogen and nitrogen are evolved,—these combining to form ammonia, which coming in contact with the fatty acids of the fat, a soap is formed.

The process of saponification takes place most rapidly in young fat persons; next, in those adults who abound in fat, and in those whose bodies have been exposed to the soil of water-closets or immersed in water; and lastly, in those who have been buried in moist, damp soil. The muscular tissue appears to be the first to undergo this change.

Table showing the Order in which the Internal Organs undergo Putrefaction.

1. The trachea.	9. The heart.
2. The brain of infants.	10. The lungs.
3. The stomach.	11. The kidneys.
4. The intestines.	12. The bladder.
5. The spleen.	13. The gullet.
6. The omentum and mesentery.	14. The pancreas.
	15. The diaphragm.
7. The liver.	16. The blood-vessels.
8. The adult brain.	17. The uterus.

II.—Internal.

A. *Organs which putrefy early.*

1. *The Trachea, including the Larynx.*—This rapid change in the trachea must be borne in mind, in order to avoid the error of attributing death to suffocation or drowning. An examination of the trachea should never be omitted. (See Casper, vol. i. p. 45, Syd. Trans.)

2. *The Brain of Infants up to the First Year.*

3. *The Stomach.*—The first traces of putrefaction are seen in from four to six days after death. All the coats of the stomach are softened, and there is no excoriation, as is the case when corrosive poisons are taken. Emphysematous separation of the mucous coat may be present, but must not be confounded with the excoriation just mentioned.

4. *The Intestines.*—Casper declares that he does not remember any case in the course of his experience where the intestines were 'found earlier putrefied than the stomach.' In the course of putrefaction they become of a dark-brown colour, bursting, and allowing an escape of their contents; and they ultimately become changed into a dark pultaceous mass.

5. *The Spleen.*—This organ in some cases putrefies before the stomach and intestines; but, as a rule, it resists decomposition longer.

6. *The Omentum and Mesentery.*

7. *The Liver.*—This organ is not infrequently found firm and dense some weeks after death. It putrefies earlier in new-born children than in adults. The convex surface first shows signs of putrefaction. The gall bladder also remains for some time recognisable.

8. *The Adult Brain.*—The brain of newly-born children, as mentioned before, soon putrefies. This is not the case in the adult brain. Putrefaction sets in not on the surface, but at the base of the brain. A wound of the brain causes it to putrefy more rapidly than if no injury be present.

B. *Organs which putrefy late.*

9. *The Heart.*

10. *The Lungs.*—Contemporaneously with the appearance of decomposition in the heart, the lungs also begin to show signs of putrefaction, though this condition may take place earlier.

11. *The Kidneys.*—These organs are long in yielding to the putrefactive process.

12. *The Bladder.*—Nearly all the other organs of the body are in a state of decomposition before this viscus becomes materially affected.

13. *The Gullet.*—This long remains firm, even after the stomach and intestines fail to be recognised.

14. *The Pancreas.*—The body must be far advanced in putrefaction before this gland becomes affected.

15. *The Diaphragm.*—This may be distinguished after the lapse of four to six months.

16. *The Blood-vessels.*—The aorta may be recognised after the body has been interred for fourteen months.

17. *The Uterus.*—Of all organs of the body, the uterus resists the putrefactive changes longer than any other organ.—CASPER.

Table showing some important facts to be noticed with regard to Putrefaction.

1. Earliest external indication of it.
   - *a. In a body exposed to air.*—Greenish coloration of the abdominal coverings.
   - *b. In a body immersed in water.*—Face, head, and ears, gradually extending from above downwards.

2. Earliest internal indication—Found in the *trachea,* including the larynx.

3. Advanced putrefactive appearances to be expected in a body exposed to air, say from fourteen to twenty days at mean temperature, as regards—
   - *a. Epidermis.*—Raised here and there in blisters about the size of a walnut, in some places the size of a dinner plate, and quite stripped off.
   - *b. True Skin.*—Maggots cover the body, chiefly in the folds of the skin.
   - *c. Cellular Tissue.*—Blown up with gas.

4. Comparative time required to produce equal extent of putrefaction in a body in—

a. In air.—One week.
b. In water.—Two weeks.
c. In earth.—Eight weeks.

Table showing the points to be noticed in determining the Sex, Age, and Stature, from an Inspection of the Skeleton.

1. DETERMINATION OF THE SEX.

a. From the Bones generally.—The bones of the female are smaller and more slender than in the male; they are also smoother, less curved, and not so strongly marked by the attachments of the muscles. The joints are also smaller than in the male.

b. From the Thorax.—The thorax in the female is deeper than in the male, the sternum shorter and more convex, the ensiform cartilage thinner, and ossified later in life. The cartilages of the ribs are longer, and the ribs smaller, than in the male.

c. From the Pelvis.—In the female pelvis the *ilia* are more expanded and horizontal; the *sacrum* more concave; and the *os coccygis* more slender, moveable, and turned more backwards; the tuberosities of the *ischia* are wider apart, and flatter; the *pubis* is more shallow; the cartilages of the *symphysis* broader; the angle formed by the descending *rami* of the *ossa pubis* more rounded, and the pubic arch wider. The whole pelvis is shallower, and the outlets larger, than in the male. The antero-posterior diameter of the well-formed female pelvis at the brim is about $4\frac{1}{2}$ inches, the lateral diameter about 5 inches, the oblique about $5\frac{1}{2}$ inches. At the outlet, the lateral and antero-posterior diameters are about $4\frac{1}{2}$ inches respectively.

Before the age of puberty, the differences in the male and female skeleton are not well marked.

2. DETERMINATION OF AGE.

a. From the Ribs.—More or less complete ossifica-

tion of the cartilages as age advances. In the very aged, the cartilages may be completely ossified.

b. From the Skull.—The imperfect ossification of the bones of the head points to early childhood. Later in life the bones are solidly united, but become thin from the absorption of their *diplöe.*

c. From the Jaws.—The toothless narrow lower jaw of the aged is very characteristic, the narrowing being due to the loss of the teeth, and subsequent absorption of the alveolar process of the jaw.

3. DETERMINATION OF STATURE.

a. When the complete Skeleton is found.—The body must be laid out in position, and an estimate made, it being usual to allow an inch to an inch and a half for the thickness of the soft parts.

b. When only portions are found.—As there does not appear to be any uniform relation between the length of any of the long bones and the stature of the entire skeleton, no reliable data can be arrived at by the measurement of a bone alone. Taylor remarks, that 'the best that can be said of this mode of measurement is that it can never be proved wrong; for, in general, there can be no witness to speak to the stature of the person while living.'

ASSAULTS AND HOMICIDE.

WOUNDS.

Legal Definition.—According to the statute (24 & 25 Vict. c. 100, s. 18), the word 'wound' includes incised, punctured, lacerated, contused, and gunshot wounds. But to constitute a wound within the meaning of the statute, the *whole skin*, not the mere *cuticle*, or upper skin, must be divided (*R.* v. *M'Loughlin*, 8 C. and P. 635). But a division of the *internal* skin, *e.g.* within

the cheek or lip, is sufficient to constitute a wound within the statute (*R.* v. *Warman*, 1 Den. C. C. 183). If the skin be broken, the nature of the instrument with which the injury is inflicted is immaterial. A wound from a kick with a boot is within the statute (*R.* v. *Briggs*, 1 Mood. C. C. 318). Injuries which, in accordance with the above definition of a wound, are not wounds, are provided for under the clause, 'or cause any grievous bodily harm to any person.'

Casper defines 'an injury' to be '*every alteration of the structure or function of any part of the body produced by any external cause.*' Dr. Taylor proposes the following as the best definition which we can at present give to the word 'wound,' whether in a medical or legal sense, that it is '*a breach of continuity in the structures of the body, whether external or internal, suddenly occasioned by mechanical violence.*' This would include dislocations, fractures either simple or compound, injury to the skin or mucous membrane, and to internal organs.

Concerning Wounds in general.—Great care should be taken to ascertain the exact site and course of the injury on the body, as this precaution will greatly assist in answering the questions: Is the wound dangerous to life? Is the wound *suicidal*, that is, inflicted by the person on himself, or *homicidal*, inflicted by another? The solution of the question of the dangerous character of the wound is left to the professional knowledge of the witness, who may be required to state his reasons for considering the wound dangerous to life. His mere assertion will not be accepted. As a general rule, only those wounds in which the danger to life is imminent should be stated as dangerous to life. Compound fracture of the bones of the cranium, injury to any large arterial trunk, or to any of the internal organs, may be considered as 'dangerous to life;' but where the danger is more remote, as in the probable super-

vention of tetanus, erysipelas, etc., the medical opinion must be more guarded.

Injuries to the Head.—All injuries to the head are more or less severe and dangerous. Scalp wounds are dangerous from erysipelas, etc.

The symptoms of compression are not infrequently retarded, and this consideration should render the opinion more guarded. Concussion and compression differ in this: in the former, the effects are instantaneous; in the latter, a short time elapses before the symptoms make their appearance; and these become more and more marked, whereas in concussion they gradually pass off. The structural form of the cranium may have much to do with the danger to be expected from blows, some skulls being thinner than others, and in a few rare instances the fontanelles may not have become ossified during life. The possibility of an unhealthy condition—atheroma—of the arteries of the brain, or of disease of the heart, must be taken into consideration before venturing an opinion as to the tendency or ultimate cause of death. It may be stated that the patient died of apoplexy. This, which is a disease of old age, seldom occurs in the young, although it is just possible it *might* occur. When violence is used, the effusion is on *the surface* of the brain; this is not the case in apoplexy. Blood may be found in the cavity of the arachnoid in the great majority of severe injuries to the head, and even in trifling cases where least expected. The blood is chiefly found over the cerebrum, next over the cerebellum, and least of all over the medulla oblongata. The blood becomes changed, and forms a false membrane on the *parietal* arachnoid, seldom on the *visceral* surface. Blood cysts may even be formed in the course of time, having all the appearance of a serous membrane. There are no symptoms to aid the diagnosis of extravasation into the arachnoid. The blood may spread to parts remote

from the seat of injury. Fits of passion have been pleaded as a cause of apoplexy, but this cause is rare. The extravasation does not always occur at the exact spot of the application of the blow, but often at a spot directly opposite. Two extravasations may be the result of one blow. Fracture of the cranial bones may be due to counter-stroke—*contre-coup*—or to falls on the nates, etc. Punctured wounds are always dangerous, but the patient may survive many days. For the detection of brain substance on weapons the microscope is alone reliable, and then only the tubular portion of the brain is of any use.

Wounds of the *face* are not generally dangerous, unless they penetrate the brain.

Wounds of the *throat* are more or less dangerous, due to the possibility of severe hæmorrhage, emphysema, and bronchitis.

Wounds of the *chest* are dangerous, on account of the amount of the hæmorrhage which may take place, and the importance of the organs which may be injured. Persons wounded in the chest may be able to walk a short distance, and then to drop dead. It is often difficult to make out the direction of the wound, as the lungs change their position during respiration.

Wounds of the *abdomen*, penetrating the intestines, may cause peritonitis, due to the escape of the intestinal fluids, and death be the result. The cœliac plexus may be much damaged by a blow on the stomach, and death may result, without leaving any trace of the injury externally. Coagulable lymph, the effect of a wound of a serous membrane, may be thrown out in twelve hours or less.

Wounds on the *genital organs* of the female may cause fatal hæmorrhage, which takes place from the plexus of veins in those parts. A kick may rupture the labia, and death may be the result.

THE SEVERAL KINDS OF WOUNDS.

1. *Incised.*
2. *Punctured.*
3. *Lacerated and contused.*
4. *Gunshot.*

1. *Incised Wounds.*

Made by sharp instruments. The Germans divide incised wounds into 'cut' and 'hewing' wounds.

General Characters.—Incised wounds are longitudinal, somewhat spindle-shaped; the edges are smooth and slightly everted, and always larger than the weapon which inflicted them—due to retraction of the divided tissues. The cellular tissue is infiltrated with blood, and coagula are found at the bottom and between the lips of the cut. It must be borne in mind that a wound with smooth edges may be made by a *blunt* weapon over bones near the surface, as on the scalp and over the tibia or shin.

It is often of importance to distinguish where the weapon entered, and where it was drawn out. The end where the weapon entered is usually more abrupt than the other, which is naturally more drawn out.

The danger from incised wounds is due to hæmorrhage.

Death from Hæmorrhage.—The surface of the body, lips, and gums, are pale and exsanguine. The venous trunks, lungs, and other organs contain but little blood, but the veins of the *pia mater* are generally not emptied. Hypostasis, both external and internal, occurs on dependent parts of the body. Blood is found round the body, unless the hæmorrhage has been internal. It is often impossible to detect the particular vessels from which the blood has flowed; but this is not of much importance. The signs of death from this cause may be rendered obscure by putrefaction; but if nothing is found to account

for death but the presence of a wound, we must conclude that death has been caused by it.

2. *Punctured Wounds.*

The orifice is generally a little smaller than the weapon. A stab may sometimes present the appearance of an incised wound; the depth will, however, help to distinguish the one from the other. The wound may not at all correspond with the shape of the weapon, and the same pointed instrument may produce very different-shaped wounds in different parts of the body. Punctured wounds are always more dangerous than incised. They cause little hæmorrhage externally, unless a large vessel, as the femoral artery, be injured. The wound generally heals by suppuration, and not infrequently an abscess is found in and around the track of the wound. Perforating wounds have generally a large entrance wound with inverted edges, and a small exit with everted edges; but if the weapon be rough, the reverse may be the case.

3. *Lacerated Wounds.*

The edges of these wounds are never smooth, and generally do not correspond at all with the weapon. Hæmorrhage from them is usually slight. Lacerated wounds heal by suppuration, generally with more or less sloughing. Scratches with the finger-nails may be considered as lacerated wounds, but the skin is merely abraded, not divided. They are never important as wounds, but often as a proof of a struggle in cases of rape, etc. Bites are also lacerated wounds.

4. *Gunshot Wounds.*

The appearance which gunshot wounds present, will to a great extent depend upon the form of the projectile, and the distance at which the firearm was

discharged. Round balls make a larger opening than conical. Small shot, fired within a short distance of the body, make one large ragged opening. The scattering of the shot depends on the calibre of the gun, on the charge of powder, and essentially on the distance. A charge of ordinary—No. 5—shot, to make a single hole, must have been fired at less than *one foot;* but experiments should always be made with the alleged weapon. A patent cartridge would make a single hole at a considerable distance—five or six yards. Round bullets may split, but this conical ones seldom do. The edges of wounds produced by the discharge of firearms are always more or less ecchymosed; this condition appears in about an hour after the infliction of the injury. If the ball strike obliquely, the edges of the wound may be much lacerated, or the opening may be valvular. The wound may be of small size, if the skin over the part be in any way tightened. The injury to bones is greater from conical than from round balls. The track of the ball *widens as it deepens.* This is the reverse of an ordinary punctured wound. The ball may either lodge in a part, or perforate it. Should it have lodged, it must be preserved and compared with the alleged firearm. The old round balls were easily deflected; the conical are not so easily turned aside. Bits of clothing or wadding may be carried into the wound. The latter should be carefully kept, as they may prove important as a means of identification. The aperture of entrance and exit must, if possible, be determined. On this point there is much difference of opinion. The wound of exit is always *smaller* than the wound of entrance (Casper). The opening of entrance made by the ball has generally, but by no means always, inverted edges. The edges of the exit opening are everted; but both may be everted in fat persons, due to protrusion of the fat; and this eversion may also result from the expansive power of the gases, generated

during putrefaction, should this condition be present. Wounds made by *double shots*, as from double-barrelled guns or pistols, or from slugs fired from one barrel, diverge after their entrance into the body.

In the examination of gunshot wounds we have to consider—

1. *Direction in which the gun was fired.*
2. *Distance at which the charge was fired.*

1. *Direction in which the gun was fired.*—The track and position of the ball in the body, coupled with the relative position of the body to a window or door through which the gun may have been discharged, and the place where the ball is found, may assist us in forming an opinion. It is often impossible to trace the course of the ball through the soft parts of the body; but through the muscles and denser structures this is more easily accomplished. The effects of the ball on surrounding objects may assist very much in finding the direction of its course.

2. *Distance at which the charge was fired.*—In the case of wounds inflicted by small shot, the scattering of the shot must be our guide. The absence of scorching, or marks made round the wound by the half-burnt powder, allows of the assumption that the shot must have come from some distance rather more than four feet. The absence, however, is not an absolute proof that the shot has come from a distance.

There is no means of deciding, from an examination of a pistol or gun, when the weapon was last used.

Dying Declarations.—The greatest care must be taken by the medical man who is called in to see a person supposed to be dying, with regard to any declaration he or she may wish to make. He should simply take the statement as it is made, writing it down on the spot, or as soon after as possible. The identical words used should be committed to paper,

and no suggestions or interpretations of his should be made. Leading questions should *never* be put, or any attempt made to induce the patient to make any statement. When we consider the condition of the patient, the possibility of delirium induced by the severity of the injury, together with the dread of death, it is, to say the least, injudicious to introduce the suspected party into the room for the purpose of identification. In every case, however, it is advisable for the medical attendant, as soon as he sees that the case must end fatally, to acquaint the patient in the presence of others of the fact, when any statement made may then be taken. It should also be borne in mind by those receiving dying declarations, that 'it must be shown that the deceased, at the time he made the statement, was under the impression that death was impending; not merely that he had received an injury from which death must ensue, but that, as the popular phrase goes, he then believed he was on the point of death' (*R.* v. *Forester*). In the case of *R.* v. *Fagent* it was held that a declaration was inadmissible because the person making it asked some one near her whether he thought she would 'rise again,' and it was held that this showed such a hope of recovery as rendered the previous declaration inadmissible. The declaration should be signed by the person making it, and witnessed by some one present at the time.

Is the Wound Suicidal or Homicidal?—In cases of suicide, punctured, incised, and gunshot wounds are more frequently present, seldom contused wounds, unless the person threw himself from a height. Very large wounds are seldom suicidal. It is important to note the direction of a wound, in order to show whether it was caused by a fall on the weapon or not. Wounds made by suicides are generally over vital parts, and a multiplicity of wounds do not point to suicide except in maniacs, or in very old people where

the skin hangs in folds about the neck. Gunshot wounds, when suicidal, are generally found over the region of the heart, temple, or in the mouth. Presence of scorching and powder marks are important, as pointing to the probable distance at which the firearm was discharged; but their absence is no proof that the weapon was not discharged close to the body. The presence of the weapon being close to the body affords a presumption as to the possibility of suicide, its absence the probability of homicide; but the weapon may be stolen from the side of the suicide. The hands should be examined for marks suggesting the probability of suicide; contusion or abrasion of the fingers from the recoil of the pistol held unsteadily. It may be suggested that the weapon was placed in the hand by the murderer, and that contraction, the result of the *rigor mortis,* had retained it. This is a fallacy, as it has been proved that, even when the weapon has been placed in the hand prior to the accession of the *rigor mortis,* and there kept by bandages, it can be removed with ease. This is not the case, however, when the retention of the weapon is due to convulsion immediately preceding death. It is strong evidence in favour of suicide if the gun or pistol has burst by the explosion, as suicides have a predilection for overloading the weapon employed. The oldness, uselessness, or the novelty—old gun barrel—of the weapon used points also to suicide.

BLOOD-STAINS.—Blood-stains may have to be examined on clothes, on weapons, and on articles of furniture. The stains may be either *recent* or *old;* in either case, the method of identification is the same. There is not much difficulty in ascertaining whether a suspected coloration is due to blood or not; but when the question arises as to whether the blood be human or that of some other animal, the identification is in most cases impossible.

On weapons, the question may arise, Is the stain blood or rust? Heat the metal, the blood-stain will peel off; that due to rust will remain.

The method of procedure for the detection of blood may be as follows:—If the stain exists on cloth or linen, a strip of the stuff is cut off and suspended in some distilled water contained in a small test tube. Streaks of colouring matter will gradually appear descending from the cloth to the bottom of the tube, where a coloured layer will eventually be formed. If the stain be recent, the colour will be deep red; but if of older date, of a reddish-brown hue. If one strip of the stuff does not yield a solution of sufficient intensity of colour, other strips may be treated in a similar way till the requisite degree of intensity is obtained. In stains on wooden articles, a splinter may be cut off and treated as above.

Half of the solution thus obtained may be treated with a little dilute ammonia, which, if the colour present be due to blood, will cause no other alteration than a *slight* heightening of the colour. If, however, the coloration is of vegetable origin, the addition of the ammonia will change it to *green* or crimson.

If the other half of the solution is now boiled, the colour will disappear, with the formation of a dirty brown precipitate. Any stain which gives, when thus treated, these reactions, is almost sure to have arisen from the presence of *blood*.

The *form* of the corpuscles should be noted. For this purpose, the stain may be moistened with a little glycerine or saliva. After standing for some time, the resulting liquid may be placed on a glass slide and examined under the microscope. The blood corpuscles will, of course, be always more or less shrivelled and disfigured, but their general appearance may be noted. The corpuscles of human blood are minute, round, flattened cells, about $\frac{1}{3000}$ to $\frac{1}{4000}$ of an inch in diameter, slightly depressed and concave in the centre,

consisting of a colourless envelope containing a red fluid. The blood corpuscles of all the mammalia are of the same shape and character, differing only to a slight degree in size. In birds, reptiles, and fishes, the blood-cells are more or less *oval* in form.

The stain should likewise be examined for crystals of hæmin. In order to procure them, the stain should be treated with a little glacial acetic acid, and the resulting solution gently evaporated on a glass slide. If, on submitting the residue to microscopical examination, no crystals are observed, fresh acetic acid must be added, together with a small quantity of common salt, and the solution again evaporated; and in the event of this failing to produce them, the above process may be repeated a third or fourth time. The form of the crystals differs in the blood obtained from different animals. In man the crystals are rhombic, of a dark red colour, frequently arranged in stellate groups, and are very uniform and characteristic.

The spectroscope has lately afforded valuable help in the identification of blood-stains. A solution of the colouring matter is placed in a narrow glass cell, and examined with the spectroscope, when the modifications in the spectrum noticed on p. 39 will be seen.

Table recapitulating the Characters of Blood-stains, under the following heads.

a. Ocular Inspection.—Blood-stains on dark-coloured materials, which in daylight might be easily overlooked, may be readily detected by the use of artificial light, as that of a candle brought near the cloth. Blood-spots, when recent, are of a bright red colour if arterial, of a purple hue if venous; the latter becoming brighter on exposure to the air. After the lapse of a few hours, blood-stains assume a reddish-brown tint, which they maintain for years.

b. Microscopic Demonstration.—With the aid of the

microscope, blood may be readily detected by the presence of the characteristic blood-cells; but even this means of diagnosis may be rendered useless, by

1. The blood being long effused.
2. The spot being wetted and then dried.
3. The blood being mixed with other substances.
4. The spot on the cloth being much rubbed, or the cloth washed.

c. Action of Water.—Water has a wonderfully solvent action on blood, the stains rapidly dissolving when the material on which they occur is placed in cold water—a bright red solution being formed. Rust is not soluble in water.

d. Action of Heat.—Blood-stains on knives, etc., may be readily removed by heating the metal, when the blood will peel off, at once distinguishing it from rust. Should, however, the blood-stain on the metal be long exposed to air, spots of rust may be mixed with the blood, when the test will fail. The solution obtained in water is coagulated by heat, the colour entirely destroyed, and a flocculent muddy brown precipitate formed.

e. Action of Caustic Potash.—The solution of the blood obtained in water is boiled, when a coagulum is formed, soluble in hot caustic potash; the solution formed being greenish by transmitted, and red by reflected light.

f. Action of Nitric Acid.—Nitric acid added to a portion of the watery solution produces a whitish grey precipitate.

g. Action of Guaiacum.—Tincture of *guaiacum* produces in the watery solution a reddish-white precipitate of the resin; but on the addition of an etheral solution of *peroxide of hydrogen*, a beautiful blue colour is developed. Other red colouring matters give a reddish colour to the precipitated resin, but the blue colour does not appear when treated as above.

h. Hæmin Crystals.—These are produced by treating

a drop of blood, or a watery solution of it, with glacial acetic acid in a watch glass, and then evaporating the mixture. The dried residue now contains the crystals of hæmin, which may then be examined under the microscope. The crystals are rhomboidal in form, tubular, or 'otherwise,' of a yellowish, yellowish-red, or dirty blood-red colour. When the stain is old, a small quantity of table-salt should be added to the acetic acid solution of the colouring matter of the blood.

i. Spectroscopic Appearances.—Two dark absorption bands appear situated at the junction of the yellow with the green rays, and in the middle of the green rays of the spectrum. The spectrum of alkanet root in solution of alum is like that of recent blood, but differs in having a third absorption band between the green and the blue. This test requires care and considerable practice at spectrum analysis.

There is no means of detecting menstrual blood from human blood the result of a wound.

Points of Importance to be noticed in the Examination of a Person found wounded.

a. Note situation, extent, depth, breadth, length, and direction of wound.

b. Is there any appearance of ecchymosis, or is the effused blood liquid, or coagulated?

c. Examine wound as to presence of pus, adhesive inflammation, gangrene, or foreign bodies.

Why? Presence of pus, etc., will show that death must have taken place some time after the wound was inflicted.

d. In all examinations of wounds, be careful to disturb as little as possible their outward appearance, in order to compare the wound with the suspected weapon.

e. All notes should be taken during such examination, or *immediately* after.

f. Make a careful examination of all the important organs of the body.

Why? In order to disprove the suggestion that death was due to other causes—poison, disease, etc.

g. Only facts should be stated in the report; *no inferences* should be drawn or suggested.

h. In describing the appearance of wounds, use *simple, untechnical language*, and avoid superlatives and high-flown words to describe and explain simple facts.

i. In gunshot wounds, note position of body, state and contents of the hands, and the direction of the wound in relation to external objects.

CONCUSSION OF THE BRAIN, ETC.

Concussion of the brain may arise from falls on the nates, or from blows on the head.

Symptoms.—The face becomes pale, the pupils contracted, the pulse weak and small, the respiration scarcely perceptible, and the sphincters relaxed. Reaction succeeds; the pulse quickens, the skin is hot and dry, there is great confusion of thought, and vomiting is present in most cases. Concussion often passes into compression, due to hæmorrhage from lacerated cerebral vessels. Great care is required in forming a prognosis with regard to the ultimate effect of an injury to the head. Inflammation of the brain and membranes may be delayed for some weeks. It is often a difficult matter to distinguish the effects of concussion from those common to drunkenness or narcotic poisoning. The odour of the breath and the history of the case will assist in forming an opinion.

BURNS AND SCALDS.

A *burn* is caused by the direct action of flame, or the application of any highly heated substance to the

surface of the body. A *scald* is due to the action of boiling water or other fluid on the body. Burns sometimes present little more than a slight redness of the skin, which may pass off in a few days; at other times blisters are formed, the base of the blister being red, with a narrow red line round it. Burns may result from only a slight application of heat, due probably to the thinness of the skin in some individuals. Often troublesome ulcers are formed, or the skin may be charred. On the same person, the appearance of each burn may be different. The danger from burns depends more on the extent of surface injured than on the intensity of the burn. Burns of a half or third part of the body must be regarded as fatal. They may prove fatal by shock, by asphyxia, or by constant and profuse discharge from the burnt surface. Children are most obnoxious to burns and scalds, the simplest often proving fatal. Persons have often been murdered and then burnt in order to conceal the crime.

Was the burn inflicted before or after death?—Two characteristic appearances—redness and vesication—are present in burns inflicted during life, when the surface of the body is not charred and the tissues destroyed. The redness affects the surface and entire substance of the true skin, which is dotted by the deep red openings of the sudoriferous and sebaceous ducts. Blisters are formed by a temperature somewhat less than that of boiling water.

In burns produced after death, the surface and substance of the true skin is of a dull white colour, dotted with grey openings of the sudoriferous and sebaceous ducts, and the subcutaneous tissues are uninjected. It may be necessary to distinguish the vesicles due to a burn, from the phlyctænæ, the result of advanced putrefaction. The vesications produced by a burn have a *purple red line* at their circumference, and a more or less *red* base. *Bullæ*, the result of putrefaction, possess none of these characteristics. Their base

does not differ in colour from that in the immediate neighbourhood of the vesicle. It appears possible to produce vesication by the application of intense heat after death; but these vesicles possess none of the appearances of vital reaction. The bullæ thus produced soon burst, and never contain serum, but only a thin watery vapour. The redness of the base, and the red bounding line round their circumference, so characteristic of burns inflicted before death, are also absent.

Was the burning homicidal, suicidal, or accidental?—No general rules for guidance can be here laid down. In most cases, the conditions under which the body is found, will point less to suicide than to homicide or accident. In cases of murder, the body is often burnt to destroy all traces of the crime. The conjunction of robbery will greatly assist in helping to solve the difficulty.

The possibility of 'spontaneous combustion' is too absurd to be more than noticed here.

CONTUSIONS, BRUISES, ETC.

These injuries are accompanied with swelling and more or less discoloration of the part affected. They might be confounded with sprains or with scurvy. From a sprain they are distinguished by pain in the joint, and the history of the case. From scurvy, by the condition of the gums—common to that disease—and by the state of the general health. Some persons are very easily bruised. Discoloration—ecchymosis—may take place in the skin, cellular tissue, muscles, or internal organs. Not infrequently, the discoloration does not appear over the seat of injury, but at some distance from it; and when the effusion is deep-seated, days may elapse before any discoloration of the skin takes place, and then it is not blue, as in

superficial parts, but of a violet, greenish, or yellowish hue. A blow given during life may not appear as an ecchymosis till *after death.* Contusions in deep-seated parts may give rise to abscess. The change of colour in bruises begins at the circumference, and travels inwards. During the first three days the colour of the bruise is blue, bluish-black, or black; greenish on the fifth or sixth day, and yellow from the seventh to the twelfth. The extent of an ecchymosis depends to a great extent on the looseness of the cellular tissue. A slight contusion causes a slight redness and swelling, and may leave no mark on the dead body unless death has taken place within thirty-six hours. Injuries of this kind sometimes leave a parchment-like hardness and discoloration of the skin. The part looks slightly depressed, due probably to the epidermis having been partly rubbed off, and the skin then drying. Similar marks are sometimes made by blisters. These marks may be produced on the dead body by friction and exposure to the air.

Ecchymosis is to be distinguished from a *post-mortem* stain—hypostasis—by cutting into the part. In the latter, only a few bloody points are seen; in the former, coagulated blood. In scourging there are parallel ecchymosed lines, or small spots resembling petechiæ. An internal organ may be ruptured, and yet there may be no appearance of injury externally. The liver is most commonly ruptured. The rupture is almost always longitudinal, and in some cases a portion of the gland is more or less detached. The spleen is also not infrequently ruptured; and this occurs most frequently in countries where ague prevails. Rupture of the lungs and brain is rare. When the pelvis is fractured, the bladder is found not infrequently ruptured.

Death in most cases is due to internal hæmorrhage when any of the internal organs are ruptured.

Can the appearance of a bruise be produced after death?

—It appears that all the appearance of a bruise inflicted during life may be produced within two hours after death, and in some rare cases even after the lapse of three hours and a quarter.

The size and form of a bruise should be noted.

Why?

1. *In hanging and strangulation.*—The mark due to pressure of the cord on the neck may cause a well-defined ecchymosis.

2. *In throttling.*—The pressure exerted on the throat of the deceased by the fingers of his assailant may leave marks, which may point to the means used to cause death.

In other cases of death by violence.—The impression made by the weapon used may lead to the identification of the murderer. The marks left by the wards of a large door-key once led to the identification of the assailant.

SUFFOCATION.

Death from suffocation is said to result from any impediment to the respiration which does not act by compressing the larynx or trachea.

Death from apnœa may arise from the following causes:—

1. Cessation of the action of the muscles of the chest.

2. Arrest of the action of the lungs.

3. Exclusion of atmospheric air from the lungs by foreign bodies lodging in the trachea.

Suffocation may be caused by pressure on the chest, as in persons crushed in a crowd. It may also be due to the respiration of certain gases or the presence of pulverulent substances in the air, which act by choking up the air-passages. Strychnia, by contracting the muscles of the chest, produces death

by suffocation. Abscesses may burst into the trachea, or vomited matters in drunken persons may lodge in the windpipe, and death from suffocation be the result.

Signs of Death by Suffocation.—The first effect of arrest to the passage of air into the lungs is the stagnation of blood in the capillaries of the lungs. Non-arterial blood then goes to the brain, and consciousness is soon lost. The respiratory sensation is then arrested by the circulation of venous blood. The left side of the heart becomes emptied, and then weak; the right side full and engorged. The great venous trunks are also more or less full. The arrest of the heart's action is a secondary effect; the right side is paralyzed by being too full, the left by being empty. The heart continues to contract after the lungs have ceased to perform their duty. Death is thus due to apnœa,—that is, death beginning at the lungs,—and not to syncope. Death in some cases is from neuro-paralysis or nervous apoplexy. In death by shock, which in most cases is instantaneous, both sides of the heart are equally filled. Death the result of disease may present all the signs of death from suffocation, and no suspicion may be aroused as to the cause of death from the *post-mortem* appearances, especially if putrefaction has set in. The following table is given as an aid to diagnosis in this form of death.

Points to be noticed in forming a Diagnosis of Death by Suffocation.

1. *The Blood.*—There is *unusual fluidity* of the blood found in any form of death by suffocation.

This condition is sometimes present in death due to certain diseases,—fevers, etc.,—and in cases of narcotic poisoning. Even with the blood in this condition, the presence of coagula in the cavities of the heart is not infrequent. The colour of the blood is changed to a dark purple.

2. *Animal Heat.*—In persons dead from suffocation the animal heat is long retained.

3. *Cadaveric Rigidity.*—Other things being equal, the *rigor mortis* is as well marked in this kind as in other forms of death.

4. *The Lungs.*—Hyperæmia of the lungs is rarely absent. In most cases, both lungs are engorged in about equal proportions. Hypostasis—*post-mortem stains*—must not be mistaken for capillary engorgement.

5. *The Heart.*—Engorgement of the right side of the heart, the left being empty or nearly so. It is advisable always to examine the heart first, and then the lungs. The pulmonary artery is also much congested.

6. *Capillary ecchymoses.*—These appear as purplish-red spots on the pulmonary pluræ, on the surface of the heart, aorta, and even on the diaphragm. They may appear on the above-mentioned parts in a fœtus suffocated *in utero* by pressure on the cord. These ecchymoses are rarely seen on adults, most frequently on infants, due probably to the thinness of the coats of the capillaries, which are ruptured in the effort to breathe.

7. *Condition and Appearance of the Trachea.*—The mucous membrane of the trachea is injected, and appears of a cinnabar-red colour. This is present in every case of death by suffocation, and must not be confounded with the dirty cherry-red or brownish-red coloration due to putrefaction. If suffocation be slowly produced, a quantity of frothy mucus may be found in the windpipe, and also in the smaller tubes of the lungs. Always examine the trachea for foreign bodies, the presence of soot, etc.

8. *Kidneys, Vena Cava, etc.*—The quantity of blood in the kidneys is always considerable. The abdominal veins are all more or less congested, and the external surface of the intestines present numerous traces of venous congestion.

9. *The Brain.*—Apoplexy of the brain, as secondary to the pulmonary apoplexy, may be more or less present, attended with its well-known appearances.

10. *Face, Tongue, and Mouth.*—The expression of the face is not characteristic of death by suffocation, and differs in no particular from that common to other forms of death, being more frequently pale than turgid, and starting of the eyes is not often seen. The tongue may or may not be protruded beyond the teeth. The presence of *froth* about the mouth is not constant, but is of common occurrence in those dying from natural causes.

Was the suffocation homicidal, suicidal, or accidental? —Suffocation may occur accidentally during the act of swallowing, and by foreign bodies placed carelessly in the mouth and then forced suddenly into the windpipe. Examine the lips for the presence of ecchymosis and other marks of violence. In France, a favourite mode of committing suicide by suffocation is the use of irrespirable gases—carbonic acid, carbonic oxide, and the like. Collateral circumstances must be taken into consideration, and will more or less help to point to the true cause of death.

HANGING, STRANGLING, AND THROTTLING.

Hanging.—Death by hanging is caused by the more or less perfect suspension of a body by a cord applied round the neck, the weight of the body acting as the constricting force.

Strangling.—Death due to pressure made on the neck by any form of ligature carried circularly round the neck. The cord in hanging is placed more obliquely than in strangulation.

Throttling.—Death due to the constant pressure of the fingers on the throat.

The cause and nature of the death in all of the

forms just mentioned is in general the same. Pressure on the trachea—thus arresting respiration—and also on the important vessels and nerves of the neck, produces death, which may be brought about in four different ways :—

1. Cerebral congestion, or apoplexy.
2. Congestion of the lungs and heart.
3. Combination of the above — apoplexy and asphyxia.
4. Neuro-paralysis—nervous apoplexy.

The following table will show the relative frequency of each form of death :—

	Remer.	Casper.
Apoplexy, . . .	9	9
Asphyxia, . . .	6	14
Mixed, . . .	68	62
	83	85

Hanging.—Death may occur in any of the forms above stated. Sensibility is soon lost, and death rapid. The external appearances are more or less those described under death from suffocation. In the greater number of cases, the face bears a quiet placid expression, no turgidity or lividity being noticeable. The eyes are not protruded. The tongue does not hang out of the mouth, nor is it bitten by the teeth.

Turgescence of the male and female genitals is said by some to take place. Casper states that, in not one of the many cases he had examined of persons hanged, has he ever 'found an erection of the male organ,' and he also asserts that the emission of semen is extremely rare. Seminal emissions take place in persons who have been shot, and also in those who have been poisoned by irrespirable gases and by hydrocyanic acid. As a test of strangulation, it is therefore worthless. The escape of urine and fæces is of common occurrence, but is by no means a test of hanging, as it may occur after death if the body be shaken in a cart,

or roughly used when first found. A fat person dying of apoplexy may have a mark round the neck as if strangled. Injury to the spinal cord due to fracture or dislocation of the cervical vertebræ is rare in suicidal hanging. Fracture of the spinal ligaments and of the hyoid bone is also rare. Rupture of the internal and middle coats of the carotid arteries sometimes occurs. Death from hanging may take place although the toes or other parts of the body rest on the ground. Death is complete in four or five minutes.

Marks of the Cord.—The mark of the cord is often interrupted, sometimes only seen on one side. In strangling, the mark is low down, most frequently encircling the neck; in hanging, the mark is generally above or on the thyroid cartilage, and carried obliquely upwards. The mark of the cord may be of a dirty yellowish-brown colour; and when cut into, feels more or less hard and leathery. In general appearance, it is not unlike the mark left by mustard plasters or blisters applied within a short time of death. This effect is probably produced by the rubbing off of the epidermis, and subsequent drying up of the cutis on exposure to the air. At other times the mark may be of a dirty reddish or bright blue colour; or, lastly, there may be little or no mark present, or the edges may assume a livid red coloration, being nothing more or less than a *post-mortem* stain. The marks left by the act of throttling are the same as those produced by hanging and strangulation, only differing in form. The impression of the fingers is upon opposite sides of the throat, and are more or less separated. The skin presents at times the parchment-like appearance just described, with slight ecchymosis under the patches. The impressions left by the nails may sometimes be seen.

May the mark of the cord be produced after death?

On this point Casper says: '*That any ligature with which any body may be suspended or strangled, not only*

within a few hours, but even days after death, especially if the body be forcibly pulled downwards, *may produce a mark precisely similar to that which is observed in most of those hanged while alive.*' And the same authority also adds, that '*the mark of the cord is a purely cadaveric phenomenon.*'

Suicide or Homicide?—The answer to this question must be framed in accordance with the history of the case, and the attendant circumstances under which the body was found. Homicidal hanging is so rare as scarcely to require notice, and it also presupposes a vast amount of strength on the part of the assailant to accomplish his purpose. Suicidal hanging—a favourite mode of death with suicides—is common enough. The absence of marks of injury on the body found suspended, and the want of evidence as to a previous struggle having taken place, all point to suicide. Throttling is never suicidal; strangulation may or may not be the act of a suicide, but the evidence is in favour of homicide. It must also be remembered that murderers not infrequently suspend their victims after death, to give an air of suicide to the transaction. In all doubtful cases, therefore, the stomach should be examined for poison, and the body for bruises, which latter may, however, be inflicted by the suicide on himself in his struggles before death ensues. The fact that the feet are found in contact with the ground does not militate against the probability of suicidal hanging.

PRETENDED ASSAULT.

How may wounds alleged to have been the result of an assault be shown to have been self-inflicted?—By considering—

1. *The Character of the Wounds.*—In these cases the wounds are generally slight, and may consist in a series of small superficial wounds.

2. *The parts of the Body where they are, and those where they are not.*—They are never found on vital parts, but always where there is little danger of doing much harm.

3. *The Clothes of the Person pretending to have been assaulted.*—The cuts in the clothes do not, as a rule, correspond with those on the body; for instance, a long cut in the coat and a short one on the body, or *vice versa.*

DROWNING.

Death by drowning occurs when the breathing is arrested by watery or semi-fluid substances, blood, urine, or the muddy semi-fluid matter found in cesspools and marshes. It is not necessary for the whole body to be submerged. Death may result if the face alone be immersed, as in the case of a man in a fit of drunkenness being drowned in the water contained in the imprint of a horse's hoof left in the mud.

In addition to the changes in the internal organs identical with those present in persons who have died from suffocation or hanging, water is found in the lungs and stomach. Death may be due to—

a. Apoplexy.
b. Asphyxia.
c. A combination of the two.
d. Neuro-paralysis.

Death from pure apoplexy is rare.

It is more difficult to restore the drowned than those dying from mere stoppage of air from entering the lungs.

In death from drowning, the lungs are distended and overlap the heart, and have a peculiar spongy feel. They also contain a quantity of frothy fluid, which, according to Casper, cannot be produced in the dead body, as it is the result of the violent efforts made by the individual to breathe in the act of dying. This frothy condition of the fluid in the lungs is an

important sign of death by drowning, especially if the fluid corresponds with that in which the individual is said to have perished. It is just *possible*, however, that the person may have been first suffocated and then thrown into the water, froth in the trachea being found in those suffocated. Water in the stomach is an important indication of death from drowning, especially if the water contained in the stomach can be identified with that in which the body was found. Casper concluded that a person had been drowned by finding a small quantity of mud in the stomach after putrefaction had set in.

Of the external signs, the presence of sand, gravel, or mud under the nails, may or may not be an important sign, for sand or mud may collect under the nails during the efforts to drag the body from the water. The *cutis anserina*—goose skin—present generally on the anterior surface of the body, and not, however, peculiar to death from drowning, is important as a sign of recent vitality. The face of those who have been drowned, and then quickly removed from the water, is pale, and in most cases not swollen, the eyes closed; and not infrequently round the mouth there is more or less froth, especially when death is due to asphyxia. In summer, however, after two or three days, and longer in winter, the face assumes a reddish or bluish-red coloration, putrefaction taking place about the head and upper extremities earlier than in other forms of death. The *contraction or retraction of the penis* is a well-marked sign of death by drowning, and Casper asserts that he has 'not observed anything similar so constantly after any other kind of death.'

Suicide or Homicide?—Homicide by drowning is rare, except in children. Accidental drowning is common enough. The signs to be sought for are—

1. Absence of any injury.
2. *Cutis anserina* and retracted penis.

3. Water and mud in the stomach.
4. Froth in the air-passages.
5. Distended lungs.
6. General signs of death by asphyxia.

It should be remembered that the fact of the hands being tied together or to the feet does not militate against suicide by drowning.

If wounds and other injuries be found on the body, the question arises as to whether the injuries were sufficient in themselves to cause death, and then as to whether they were caused during life. A person jumping from a height into the water may sustain severe injuries,—dislocation of both arms, fracture of the skull and of the vertebræ, or even lacerated wounds of more or less severity. The absence of the signs proper to death by drowning, coupled with the presence of external injuries, would point to death by violence prior to immersion.

The following considerations may assist in forming an opinion :—

1. Previous history of person found in the water.
    a. Any history of suicidal tendency.
    b. Any motive that would render suicide probable.
2. Height from which the person fell.
3. Absence or presence of signs of death by drowning.

The time required to cause death by drowning is so short, that persons seldom recover after submersion for one or two minutes; but the cessation of respiration is no guide to the extinction of life, and an attempt at resuscitation should always be made; for if the respiration be fairly restored, the heart will soon act.

Recapitulation of the Post-mortem Appearances in the Drowned.

1. External.

a. In the Skin.—The presence of *goose skin—cutis an-*

serina—is hardly ever absent, even in summer. The *cutis anserina* is not, however, characteristic of drowning, as it may be present in other forms of violent death, and also in some persons during life. It is a vital act, the result of nervous shock, and does not depend upon the temperature of the water for its production.

b. The Tongue.—'The tongue is just as often found behind the jaws as between them' (Casper).

c. The Hands and Feet.—The hands and feet acquire a greyish-blue colour when the body has lain in the water from twelve to twenty-four hours. The skin also becomes corrugated in longitudinal folds. The nails may contain particles of sand and weeds. 'No corrugation or discoloration of the skin of the hands or feet is ever observed on the body of any one drowned, who has been taken out of the water within half an hour, within two, six, or even eight hours' (Casper).

d. The Genitals.—Contraction of the penis is an almost constant symptom, and Casper has 'not observed anything similar so constantly after any other kind of death.' It is due, probably, to the same cause as the *cutis anserina,* which Brettner attributes to 'bundles of unstriped muscular fibres lying in the upper stratum of the true skin, surround the sebaceous glands, and force them forwards by their contraction, thus making the *cutis anserina.* Precisely similar unstriped muscles are found in the subcutaneous cellular tissue of the penis; they run principally parallel to the long axis of the member, but very often large bundles run across it.' The action of cold and fright is to induce contraction of these cutaneous muscles, with a resulting contraction of the penis.

2. INTERNAL.

a. The Brain.—Cerebral hyperæmia is *most* rare in the drowned, but cerebral hypostasis is not infrequently mistaken for it.

b. The Trachea.—The mucous membrane of the trachea and larynx is always more or less injected, and is of a cinnabar-red colour, which must not be mistaken for the dirty brownish-red, the result of putrefaction. A white froth, but seldom bloody, is also found in varying quantity in the trachea, and is a most important sign of vital reaction, but its diagnostic value is destroyed by putrefaction.

c. The Lungs.—The lungs are completely distended, almost entirely overlapping the heart, and pressing close to the ribs. They are spongy to the feel, and when cut into, a considerable quantity of bloody froth escapes. The *froth* found in the lungs is the result of the powerful attempts to breathe, and cannot be produced by artificial means. The distension of the lungs is due partly to an actual hyperæria, partly to inhaled fluid, and partly to hyperæmia.

d. The Heart and Great Vessels.—As is common to other forms of asphyxia, the left side of the heart is entirely, or almost entirely, empty. It is therefore not a diagnostic sign of drowning, and is absent in the drowned when death takes place by neuro-paralysis. The same may be said of the accompanying congestion of the pulmonary artery.

e. The Blood.—As is common in all forms of death where respiration has been arrested, the blood is found to be remarkably *fluid*, and of a cherry-juice colour.

f. The Stomach.—Casper considers that the presence of fluid in the stomach, corresponding to that in which the body is found, is '*an irrefragable proof of the actual occurrence of death from drowning*,' and that 'the swallowing of it must have been a vital act of the individual dying in the water.'

N.B.—Putrefaction in the drowned in most cases commences in the upper part of the body, and extends downwards. The face, head, and neck are first attacked. This is the reverse of putrefaction in air.

Restoration of the Drowned.—As soon as the body is

removed from the water, it should be placed in a warm bath of the temperature of 100° F. If a warm bath is not procurable, the body should be wiped dry, and placed in hot blankets with the face downwards, to allow any water from the mouth and air-passages to drain away. All foreign bodies should be removed from the mouth and nostrils, and the tongue drawn forwards. The body may now be placed on the back, with the head slightly elevated, and rubbed with hot cloths; the arms at the same time being raised from the sides and carried above the head, retained for one or two seconds in that position, and then lowered again to the sides,—the same movement being continued till respiration is restored. Pressure may at the same time be made on the breast bone to aid exspiration. Ammonia and snuff may be applied to the nostrils.

STARVATION.

Death from starvation comes in as an item in the ill-treatment of children, and it has also been known as a form of suicide, chiefly in lunatics. Little is known for certain as to the length of time required to cause death by starvation, but it is certain that life may be prolonged for some time without food, if water be allowed.

The morbid appearances are anæmia and emaciation, together with remarkable attenuation of the coats of the intestines.

Diagnosis.—The absence of any other cause for death, and the previous history of the case, will alone assist in forming an opinion.

Recapitulation of the Post-mortem Appearances of Death by Starvation.

1. *In the Body generally.*—Marked general emaciation of the body. The skin is dry and shrivelled; the

muscles soft, reduced in size, and free from fat. A peculiar fœtid odour is given off from the body.

2. *In the solid viscera of the Thorax and Abdomen.*—The liver is small, and the heart and kidneys deprived of any surrounding fat. All the internal organs are shrivelled and bloodless.

3. *In the Stomach and Intestines.*—The stomach in some cases is quite healthy; in others it is found collapsed, contracted, empty, and the mucous membrane more or less ulcerated. The intestines are thin, contracted, empty, and so shrunken that the canal is almost obliterated.

DEATH FROM COLD.

This form of death is rare in England, but is more common in countries where the winters are severe. Anything that depresses the vital powers renders the individual more or less amenable to cold; such, for instance, as drunkenness, previous illness, or deficiency in the amount of food. There are no *post-mortem* appearances which are characteristic of death due to cold, and the fact of a body found frozen is no proof that death has been thus brought about.

Diagnosis.—The general appearance of the deceased, and the absence of any other cause of death, will alone assist in forming an opinion on this difficult subject. If a body is found buried in snow, and putrefaction present, death did not in all probability take place from cold, provided that the cold has been severe and continuous. Death from cold is generally accidental, except in newly-born children, when it may be either accidental or homicidal, according to circumstances.

DEATH BY LIGHTNING.

Death is not always immediate. Sometimes the clothes have been torn off the body with scarcely any personal injury. Steel articles worn about the person may become magnetic. Wounds on the body sometimes appear in the form of punctured wounds, at others as lacerated wounds. Not infrequently, those killed by lightning are found in the same position that they occupied during life. The question may be raised as to whether the deceased died by lightning or by violence. The presence of a storm at the time when the death is stated to have occurred, and other attendant circumstances, will in most cases point to the true cause of death.

SUICIDE.

In medico-legal inquiries, it not infrequently becomes a question of the greatest importance to decide whether the death of a person found under peculiar circumstances was brought about by accident, suicide, or by the hand of a third party. Unfortunately, there are no infallible rules to be laid down on this subject; and Casper sagaciously remarks, that 'the exercise of a sound judgment, which is of far more value in medico-legal matters than all the subtleties of the ancient *medicina forensis*,' must be our guide. But in order to attract the attention to some important subjects in the inquiry, a few points worthy of notice will be placed in a tabular form :—

1. *Has the deceased made any oral statement, or left any written declaration of his intention to commit suicide?*
2. *Has there been any marked peculiarity in the conduct and manner of the deceased to point to any mental derangement?*

3. *Conditions under which the dead body was found.*
    a. *If in a room, was the door locked on the inside?*
    b. *Position of the hand with regard to the weapon alleged to have been used.*
    c. *If weapon is found firmly grasped in hand, probability is in favour of suicide, as weapons placed in the hand after death to simulate suicide can be removed with ease, even when the* rigor mortis *is present.*
4. *Nature and character of the wounds found on the body.*

    On suicides incised and punctured wounds are generally found, seldom lacerated wounds, unless a jump from a height has been the means adopted to cause death.
5. *Evidence to be derived from a medico-legal examination of the body.*
    a. *Do the wounds correspond with the weapon alleged to have been used?*
    b. *Examination of stomach for poison.*

        Why? Persons may have been poisoned first, and then cut about the body after death.
    c. *Direction and course of wound.*
    d. *Were the wounds inflicted during life?*

Too much care cannot be taken in answering this question, as its solution is involved in considerable difficulty, and the medical jurist must not be discouraged if in many cases he is unable to give a decided opinion one way or the other. If death has followed instantaneously on the receipt of a wound, as in the case of injury to a large artery, none of the signs of vital reaction will be present, and the wound cannot be distinguished from another made by its side after death. Only in those cases where some time has elapsed between the receipt of the injury and death, will any of the signs of vital reaction be

present; and even these may be more or less modified, so as to render the diagnosis, if not impossible, at least doubtful.

With regard to the legal relations of suicide, an attempt to commit suicide is not, within the meaning of sec. 15 of 24 & 25 Vict. c. 100, an attempt to commit murder, but it still remains a common law misdemeanour, triable at quarter sessions (*R.* v. *Burgess*). If two persons mutually agree to commit suicide by poison or other means, and one survives, the survivor is guilty of murder (*R.* v. *May*, 1872). Also, if any one, in attempting to commit suicide, cause the death of another, he himself recovering, he shall be guilty of manslaughter (*R.* v. *Gathercole*). In most of the English insurance offices suicide is held to invalidate a policy, but in most cases where insanity is proved the amount of the policy is paid, as in the case of *Schwabe* v. *Clift*. Suicides are deprived of the rites of Christian burial (4 Geo. IV. c. 52, s. 1).

OFFENCES AGAINST CHASTITY.

RAPE.

Rape is defined as '*the carnal knowledge of a woman against her will.*' To constitute the offence of rape, there must be *penetration*, but proof of the actual emission of seed is not necessary. The slightest penetration of the male organ within the vulva will be sufficient, and the hymen need not be ruptured (*R.* v. *Russen*). If, however, the woman yields through fear or duresse, it is still rape; but of course much will depend upon the previous character of the woman, and her conduct subsequent to the alleged outrage. A rape may be committed on a common strumpet.

Carnal knowledge of a woman by fraud, which induces her to suppose it is her husband, does not amount to a rape (*R.* v. *Jackson,* R. and R. 487), but the party may be indicted for an assault.

Carnally abusing children under ten years of age constitutes a felony; above ten and under twelve, a misdemeanour. Under the age of ten years the evidence is the same as in rape, with the exception, however, that it is immaterial whether the act was done with or without the consent of the female. Between the ages of ten and twelve it will be no defence to say that the girl consented. Above twelve years of age, *consent* does away with any legal offence. A boy under the age of fourteen is presumed by law incapable of committing a rape.

The crime of rape appears to be most frequently perpetrated against children. The following table from Casper gives the result of his examination of *one hundred and thirty-six cases* of rape :—

From $2\frac{1}{2}$ (!) to 12 years old,	. . .	99
,, 12 ,, 14 ,,	. . .	20
,, 15 ,, 18 ,,	. . .	8
,, 19 ,, 25 ,,	. . .	7
47 ,,	. . .	1
68 ,,	. . .	1
		136

In the examination of a case of alleged rape, several points of interest will have to be considered, which, for the sake of convenience, will be placed in a tabular form.

1. *An Examination of the Parts of Generation.*
   - *a.* Inflammatory redness and abrasion of the parts.
   - *b.* A muco-purulent secretion.
   - *c.* Hæmorrhage or dried blood about the genital organs.

d. Destruction of the hymen.
e. Dilatation of the vagina.
f. General signs of rape.

2. *An Examination of the Body and Limbs of the Female.*

3. *Examination of the Linen worn by the Female for—*
a. Marks of semen.
b. Marks of blood.
c. Marks of other discharges, gonorrhœa, etc.

1. *An Examination of the Parts of Generation.*

a. More or less inflammatory *redness* and *abrasion* of the mucous membrane lining the parts, which is never absent in children, and may last for some weeks. 'In adults, virgins up to the time of the commission of the crime, this appearance is either not found at all, or only faint traces of it. In those previously deflowered it is never observed.'

Caution.—Inflammatory irritation due to catarrh *may* occur, and be apt to mislead.

b. A *muco-purulent secretion,* from the mucous membrane lining the vagina, of a greenish-yellow colour, more or less viscid, and soiling the linen of the girl. This secretion in colour and consistence cannot be distinguished from that the result of gonorrhœa.

Caution.—Unhealthy children, and those recovering from some debilitating diseases,—fever, etc.,—may suffer from purulent discharges from the vagina. Small ulcers may also be present. Infantile leucorrhœa is not uncommon.

c. Hæmorrhage or Dried Blood about the Genital Organs.

1. Frequently absent in young children.
2. Always found in adults, virgins at the time the rape was committed, when the vessels of the hymen are ruptured.

d. Destruction of the Hymen.—Most frequently, and especially in young girls, one or more *lacerations* of the hymen may be seen.

e. Dilatation of the Vagina.—This condition may be produced by the passage of hard bodies in order to substantiate a false charge of rape. Casper once examined a girl, only ten years of age, whose mother had gradually dilated her vagina with her fingers in order to fit her for sexual intercourse with men.

f. General Signs of Rape.—To the above are added certain general signs, as a *difficulty in walking*, attended with an involuntary separation of the thighs, common to both children and adults; *pain in passing water*, and when the *bowels are relieved*, is also not infrequently present. In determining the truthfulness of the statements made as to an alleged rape, the character of the woman and the obvious inconsistencies of her statements must be taken into consideration.

In the case of young children, the anxiety on the part of the parents of the child to push the charge, and the story of the child and that of the parent heard apart, may assist in guiding the opinion. The lesson-like way in which the child tells its story, even to the minutest details, is always suspicious. The proof of a previous defloration negatives the pretended loss of virginity at the time of the commission of the deed for which the accused is being tried. In most cases, it is best to let the patient tell her own tale, and then cross-examine. An injudicious question may put her on her guard.

2. *Examination of the Limbs and Body of the Female for Bruises, etc.*

Little value is to be placed on injuries said to be inflicted on the person of the female, the result of a struggle, as these may be produced by the woman on herself in order to substantiate her story. In children, for obvious reasons, they do not occur.

3. *Examination of the Linen.*

In all cases a careful examination of the body linen of both parties should be made. Mistakes may arise from—

a. The garments being intentionally soiled with blood. This is not infrequently done in cases of false accusations.

b. The menstrual discharge may be readily mistaken for that due to violence, as the two kinds of blood cannot be distinguished.

c. The red juice of fruits and grease-spots have been mistaken for marks of blood and seminal stains on linen.

The identification of blood-stains is not difficult when the stains occur on pieces of white linen; but when, as it not infrequently happens, they have to be detected on the coarse, dirty, often stinking linen of the poor, the task becomes somewhat more difficult. The same may be said with regard to seminal spots. As a means of diagnosis in stains due to semen, the appearance and smell of the stains are of no assistance whatever. The microscope will alone give any trustworthy evidence as to the nature of the stain; and even here a caution must be added: for the fact is beyond doubt, that the semen even of a healthy young man varies much, and is scarcely ever twice alike, so that the absence of spermatozoa is no proof that the spot is not seminal in its origin.

The following are the tests used for the detection of semen:—

a. Characteristic smell when the spot is moistened. This test is of no use, for the reasons before stated.

b. Appearance when held to the light as uncertain as the preceding.

c. Doubtful spots upon *cotton* or *linen*—not upon *wool*, which usually contains sulphur—are cut

out and moistened with a few drops of oxide of lead, dissolved in liquor potassæ, and then dried at a temperature of 68° F. The stain in a few minutes becomes of a dirty yellow or sulphur-yellow colour. This change in colour proves that the mark *is not* a seminal stain. This test only shows that the stain is not caused by albuminous compounds, which contain sulphur; but it does not follow that therefore the spot must be seminal, for marks made by gum, dextrine, and some other substances of a like nature, are not changed in colour.

d. The Microscope.—This is by far the most reliable test, but care is required in its manipulation.

1. The cloth must not be rubbed between the fingers, as the spermatozoa may be damaged by the operation.
2. The suspicious spot on the linen should be carefully cut out and placed in a clean watch glass or small porcelain vessel, and then moistened with a small quantity of distilled water. The cloth may be gently moved about in the water with a glass rod, and gentle pressure made so as to thoroughly wet the cloth, which in most cases will be accomplished in about a quarter of an hour. A single drop should now, by gentle pressure with the fingers, be squeezed on to a clean slide, and then placed under the microscope.

Can a Rape be committed on a Healthy, Vigorous Woman?—The answer to the question will, to a great extent, depend on the relative strength of the conflicting parties. In any case, the medical jurist has simply to state, from the examination of the parties, that sexual intercourse has taken place, leaving the jury to decide whether a rape or not has been perpetrated.

A case is mentioned by Casper (LIV. vol. iii. p. 311), where a healthy, strong adult of twenty-five years old was violated by a single man.

Can a Woman be violated during Sleep?—By this is intended natural healthy sleep, and not that induced by narcotics. Under these circumstances, rape is scarcely possible in a virgin, though it *may* be possible in a woman accustomed to sexual intercourse.

Can a Woman become pregnant by an act of Rape?—The answer to this question is most decidedly in the affirmative. It is not necessary for a woman to experience any sexual pleasure during connection in order that she may conceive.

General Directions as to manner of making a Medico-Legal Examination in cases of alleged Rape.

a. Give the female no time for preparation, but make your visit, and at once proceed to an examination.
   1. Note time of visit.
   2. Note time of alleged offence. Why?
      May prove the accused party innocent by an *alibi*.
   3. Avoid leading questions.

b. Age, strength, and condition of the health of the complainant. Examine the wounds asserted to have been inflicted, and see if they correspond with the history given of their infliction.

c. Examine organs of generation.
   1. Any recent signs of violence — blood, abraded, ulcerated?
   2. Condition of hymen, and of the *carunculæ myrtiformes.*
   3. Was the woman menstruating at the time? Signs modified or obliterated by menstruation.

d. Preserve any spots on linen, etc., for future examination.

e. In case of death after violence,
   1. Examine mouth for foreign bodies, etc.
   2. Fractures or bruises on the body.

f. Examine spot where the crime is stated to have taken place.

g. Examine person of the accused.
   1. Muscular development and strength.
   2. Any abrasion about the penis, rupture of the frænum, etc.
   3. On linen, blood-stains, seminal spots, etc.
   4. Marks on his body, scratches, etc., as evidence of resistance.

N.B.—The lapse of a few days may be sufficient to remove all traces of the violence done to the parts; and in most cases, days, weeks, and even months, may elapse before an examination is made of the alleged victim.

Physical Signs of Rape in the Adult and in the Child.

IN THE ADULT.	IN THE CHILD.
1. If examined soon after the commission of the offence, the hymen of the adult virgin may be ruptured, and the fourchette may be lacerated, and the parts covered with blood.	1. There may not be sufficient penetration to rupture the hymen, consequently there will be no hæmorrhage, but the external organs will be bruised.
2. Difficulty in walking, in passing water, and sometimes when the bowels are relieved. These signs in the adult pass off in a day or two.	2. Same as in the adult, but lasting for a longer time—from eight to fourteen days.
3. Injuries on the person abused, such as scratches and ecchymoses, may be present as the result of a struggle. These may be self-inflicted.	3. For obvious reasons, these do not occur on children.

LOSS OF VIRGINITY.

There is no one sign which may be considered as an absolute test for virginity. The presence or absence

of the hymen is of no probative value one way or the other. It may be absent as the result of disease, or as the result of a surgical operation to allow of the free discharge of the menstrual flow. Its presence is no bar to conception; and cases are on record where it has been found necessary to incise it, to allow of the passage of the fœtus into the world. The changes in the breasts which proceed from impregnation do not occur where only defloration has taken place. The rugose condition of the vagina is only affected by the first birth, and not by sexual intercourse. What has been said of the above signs as tests for virginity may be said of a host of others, which from time to time have, with varying success, been advanced as aids to diagnosis. Casper, however, considers 'that where a forensic physician FINDS A HYMEN STILL PRESERVED, EVEN ITS EDGES NOT BEING TORN, AND ALONG WITH IT—in young persons—A VIRGIN CONDITION OF THE BREASTS AND EXTERNAL GENITALS, HE IS THEN JUSTIFIED IN GIVING A POSITIVE OPINION AS TO THE EXISTENCE OF VIRGINITY, and *vice versa.*'

PREGNANCY.

It not infrequently happens that a medical man is called upon to make an examination of a woman for legal purposes, in order to decide—

a. Existence of an alleged pregnancy.

b. The possibility of a previous pregnancy.

c. As to the existence of concealed pregnancy.

The following are some of the reasons why pregnancy may be feigned:—

a. By a married woman, to gratify the desire of her husband for issue.

b. To influence the jury in a case of breach of promise of marriage as to the assessment of the damages.

c. To extort money from a seducer or paramour.

d. To produce a spurious heir to property.

e. By single or married women, to stay the infliction of capital punishment.

Pregnancy may be concealed—

a. In order to procure abortion.

b. In order to commit infanticide.

c. In the married and unmarried, to avoid disgrace.

Besides the above, other important questions may arise with regard to this state.

a. Is pregnancy possible as the result of coïtus in a state of unconsciousness?—There appears no reason for doubting the possibility of this occurrence.

b. Can pregnancy occur before the appearance of the catamenia?—That pregnancy may occur before menstruation is undoubted; and it appears probable that the changes in the ovaries and uterus may go on at the regular monthly periods, and yet there be no discharge of blood from the uterus, which, as pointed out by Bischoff, is only a symptomatic though usual occurrence. Hence pregnancy is possible prior to menstruation.

c. What is the earliest and latest age at which pregnancy is possible?—In our climate—England—the earliest age at which pregnancy may occur is between the thirteenth and fifteenth year. In hot climates, as in Bengal, mothers have been known under twelve years of age. The limit to child-bearing appears to be between the fiftieth and fifty-second year.

d. Is it possible for a woman to become pregnant eight weeks after her last confinement?—This is undoubtedly possible, but it is of rare occurrence. It is also probable that a woman may abort at the end of the time above mentioned.

At *common law*, in cases of disputed inheritance, the following may occur, and give rise to the necessity of medical evidence on the subject:—

A woman who has just lost her husband, may disappoint the expectant heirs to an estate by alleging that she is pregnant.

At *criminal law*, pregnancy may be used as a stay to the infliction of capital punishment.

In the first case, a jury of matrons is impannelled by a writ *de ventre inspiciendo*, to decide the existence of pregnancy; and if the fact is proved, to watch till such time as she be delivered.

In the second case, the pregnancy must be proved, and also whether she be *quick with child*.

SIGNS OF PREGNANCY.

The diagnosis of early pregnancy is by no means easy; but to the medical jurist it is still more difficult, as he has to deal with cases where he can scarcely expect much candour. No opinion should, however, be given without taking into consideration the collective value of the signs, as no one sign will afford sufficient data on which to base an opinion.

The following may be taken as among the most important signs of pregnancy, given in the usual order of their occurrence:—

Uncertain Signs.

a. Cessation of menstruation.
b. Morning sickness.
c. Salivation.
d. Mammary sympathies.
e. Enlargement of the abdomen.
f. Quickening.
g. Kiesteine.
h. Jacquemier's test.

Certain Signs.

1. Ballottement.
2. Uterine souffle.
3. Pulsation of the fœtal heart.

a. Cessation of Menstruation.—The non-appearance

of the catamenia, though a most valuable sign, is by no means a conclusive one, as menstruation may be arrested by diseases of various kinds; while, on the other hand, there are many well-recorded cases of women who have menstruated regularly during the whole period of their pregnancy. There have been also cases in which the menses only occurred during pregnancy. In cases of concealed pregnancy, the woman may smear her linen with blood to imitate the menstrual flow.

b. Morning Sickness.—Nausea, often ending in vomiting, generally occurs soon after rising in the morning, and may commence almost immediately, but more frequently not till the expiration of the fifth or sixth week after conception. It is not a reliable sign, and is often very irregular in its occurrence. When present, it varies in degree, from a feeling of nausea to the most violent vomiting, very distressing to the patient.

c. Salivation.—The excessive secretion of the salivary glands, due to the irritation caused by pregnancy, was first mentioned by Hippocrates as a sign of this condition. 'It is to be distinguished from ptyalism induced by mercury, by the absence of sponginess and soreness of the gums, and of the peculiar fœtor, and by the presence of pregnancy.'[1] It is oftener absent than present.

d. Mammary Sympathies.—As the breasts may enlarge from various causes,—such, for instance, as the distension of the uterus from hydatids; or, as is the case with some women at each menstrual period, when the catamenia are suspended, or after they have ceased,—this is by no means a sign on which much reliance should be placed. The change in the colour of the nipple and areola, more apparent in women of dark complexions, is more to be relied on as a diagnostic sign of pregnancy. The first observable alteration, which occurs about two months after conception,

[1] Dr. Montgomery.

is 'a soft and moist state of the integument, which appears raised, and in a state of turgescence, giving one the idea that, if touched by the point of the finger, it would be found emphysematous. This state appears, however, to be caused by infiltration of the subjacent cellular tissue, which, together with its altered colour, gives us the idea of a part in which there is going forward a greater degree of vital action than is in operation around it; and we not unfrequently find that the little glacidular follicles, or tubercles as they are called by Morgagni, are bedewed with a secretion sufficient to damp and colour the woman's dress. During the progress of the next two months, the changes in the areola are in general perfected, or nearly so; and then it presents the following characteristics:—A circle round the nipple, whose colour varies in intensity according to the particular complexion of the individual, being usually much darker in persons with black hair, dark eyes, and sallow skin, than in those of fair hair, light-coloured eyes, and delicate complexion. The extent of the circle varies in diameter from an inch to an inch and a half, and increases in most persons as pregnancy advances, as does also the depth of colour. In the centre of the coloured circle, the nipple is observed partaking of the altered colour of the part, and appearing tinged and prominent; while the surface of the areola, especially that part which lies more immediately around the base of the nipple, is studded over, and rendered unequal by the prominence of the glacidular follicles, which, varying in number from twelve to twenty, project from the sixteenth to the eighth of an inch. And, lastly, the integument covering the part appears turgescent, softer and more moist than that which surrounds it; while on both there are to be observed at this period, especially in women of dark hair and eyes, numerous round spots or small mottled patches of a whitish colour, scattered

over the outer part of the areola, and for about an inch or more all around, presenting an appearance as if the colour had been discharged by a shower of drops falling on the part.'[1] The value of the above changes in the nipple and areola as a diagnostic sign of pregnancy is greatly lessened by a previous pregnancy. It should also be remembered that milk may occur in the breasts of women who are not pregnant.

e. Enlargement of the Abdomen.—For the first four months of pregnancy the entire uterus is contained in the cavity of the pelvis; it then gradually rises, so that at about the fifth month it is midway between the pubes and umbilicus, which latter it reaches at the end of the sixth month; during the seventh month it may be felt half-way between the umbilicus and ensiform cartilage; at the end of the eighth month it is level with the cartilage, now quite filling the abdomen.

Still increasing in size during the ninth month, it does not ascend higher, the abdominal walls yielding to its increased weight, allowing it to fall somewhat forward.

The *cervix uteri* in the latter months of pregnancy presents the following characteristics:—

At the sixth month it loses one-fourth of its length; at the seventh it is only half of its original length; at the eighth it loses another quarter; and at the ninth the neck is entirely obliterated. This shortening is more apparent than real.

f. Quickening.—The period at which quickening occurs varies from the fourth to the fifth month; and the term is understood to imply the first perception of the movements of the fœtus experienced by the mother. Nervous women, anxious to have children, sometimes complain of sensations which they ascribe to quickening, pregnancy being absent. Pregnancy may occur without quickening.

[1] Dr. Montgomery.

g. Kiesteine.—This is no test of pregnancy, as it may be found in women not pregnant.

h. Jacquemier's Test.—A violet or port-wine colour of the vagina and inner surface of the vulva, due to venous congestion of the parts from pressure of the gravid uterus.

This ends the account of those signs of pregnancy which are least to be relied on in forming a diagnosis, and which are only useful when taken in the aggregate.

1. *Ballottement.*—This test of pregnancy is applied by causing the patient to stand upright; the finger of the right hand is then passed into the vagina and placed on the mouth of the womb, the other hand being placed lightly over the abdomen in order to steady the uterine tumour. If the finger be now jerked upward against the head of the child, it will be felt to float upward in the liquor amnii, and then by its own weight gradually to return to its former position. Tumours in the uterus, attached to its walls by a pedicle, may give the same sensation. Scanty supply of liquor amnii, or mal-position of the child, may sometimes prevent the adoption of the test.

2. *Uterine Souffle.*—Under this head are included the placental bruit, and the pulsations of the umbilical cord.

3. *Pulsation of the Fœtal Heart.*—The sounds of the fœtal heart were first noticed by Mayar in 1818, and those of the placenta, or *placental souffle,* by Kergaradec in 1822.

The sound of the fœtal heart is composed of a rapid succession of short, regular double pulsations, differing from that of the adult heart in rhythm and frequency. It can be heard more or less over the whole of the abdomen about the middle of the fourth month, and is not unlike the muffled ticking of a watch. In frequency it varies from 90 to 180. The auscultator should be careful not to hang his head down, or he may be apt to

mistake the throbbing of his own arteries for sounds communicated from the patient.

The medical jurist must be prepared for the following among many other questions which will come under his notice:—'An unmarried woman with abdominal enlargement has been wrongfully accused of being pregnant. Enumerate the various conditions which produce abdominal enlargement, and give the diagnosis of them.'[1] Pregnancy may be simulated by ascites, by fibrous tumours of the uterus, by ovarian dropsy, and by enlargement of the uterus from retention of the catamenia due to an imperforate hymen, and lastly, from the singular disease about to be described below. The breasts may also become affected by uterine tumours.

Diagnosis.

Dropsy.—Use of the stethoscope, examination of the breasts, and urine for albumen.

Fibrous Tumours.—Absence of fœtal movements and other signs of pregnancy.

Ovarian Dropsy.—Tumour on one side of the abdomen; breasts unaffected, and auscultation giving negative results.

Retention of the Catamenia.—On examination, the hymen found perfect and bulging. This condition cured by a crucial incision.

PSEUDO-PREGNANCY.

In the examination of cases of alleged pregnancy, the medical jurist should bear in mind the possibility of enlargement of the uterus and abdomen from the presence of tumours. The probable occurrence of *pseudo-pregnancy* should also be considered. Tumours and pseudo-pregnancy may occur in the married and

[1] See the author's *Collection of Medical and Surgical Questions*, published 1871. London.

unmarried; and as the latter is not infrequently accompanied with many of the signs and symptoms of pregnancy, an early diagnosis is of the utmost importance.

The *diagnosis* will consist in—

a. Careful examination of all the symptoms present, when in most cases a break in their order of sequence may be observed, or certain signs may be added which do not occur in true pregnancy.

b. Presence or absence of the hymen.

c. Condition and appearance of the *os uteri* (see p. 73).

d. If the patient be placed well under the influence of chloroform, the tumour, if the result of pseudo-pregnancy, will subside, gradually returning as the effects of the anæsthetic pass off. Whilst the patient is under the influence of the anæsthetic, the hand may be pressed on the abdomen at each exspiration, and there retained, the pressure being continued during the inspirations.

It is stated that Liston once cut into a woman for a phantom tumour, and declared that he had never seen more healthy bowels in his life.

DELIVERY.

This subject is best discussed under three heads:—

A. *Signs of recent Delivery in the Living.*
B. *Signs of recent Delivery in the Dead.*
C. *Signs of previous Delivery.*

A. *Signs of recent Delivery in the Living.*

a. Transitory signs of delivery.
b. Persistent signs of delivery.

a. Transitory Signs of Delivery.

1. *General Indisposition.*—The face is pale or flushed; the eyes sunken and surrounded by a dark

areola; there is considerable debility, and a tendency to faint; the skin is warm and moist, and the pulse quick. It must be borne in mind, that a woman who is anxious to conceal her recent delivery may, by an effort of the will, to a great extent hide her real condition.

2. *The Breasts.*—The breasts feel firm and 'knotty,' and on pressure yield a small quantity of *colostrum* or milk, which may be distinguished by the aid of the microscope.

3. *The Abdomen.*—The skin of the belly shows signs of recent distension: it is relaxed, and more or less thrown into folds, the lower part marked by irregular broken streaks of lighter-coloured skin.

4. *The Lochia, or 'the Cleansings.'*—This consists in a discharge from the uterus, which, for the first three or four days after delivery, is more or less bloody. During the succeeding four or five days it acquires a dirty-greenish colour—'green waters,' with a peculiar sour, rancid odour. In a few days this is succeeded by a yellowish milky mucous discharge, which may continue for four or five weeks.

5. *External Parts of Generation.*—The labia and vagina bear distinct marks of injury and distension.

6. *The Uterus.*—The uterus is enlarged, and may be felt by the hand for two or three days after delivery as a round ball, just above the pubis. The orifice of the uterus, if examined a few hours after delivery, appears as a continuation of the vagina. This condition completely disappears in about a week after delivery.

7. *After-Pains.*—These are of no use in a diagnostic point of view, as we have no means of testing their presence or absence.

b. Persistent Signs of Delivery.

1. Entire obliteration of the hymen. This is no proof of actual delivery.

2. Destruction of the fourchette.
3. The vagina dilated, and free from rugæ.
4. Dark colour of the areola round the nipples.
5. *Skin of the Abdomen.*—Due to the great distension of the abdomen, the skin in places appears streaked with silvery lines varying in breadth. The same appearance may be produced by dropsy, or the prolonged distension of the abdominal walls, the result of other causes. Attention to the other signs present will assist the diagnosis.

B. *Signs of recent Delivery in the Dead.*

Should the woman die immediately after delivery, the external parts will present the same appearance as just described in the living. On opening the abdomen, the uterus will be found flat and flabby, between nine and twelve inches long, and with the *os uteri* wide open. The cavity of the uterus may contain large bloody coagula, and its inner surface is lined by the decidua. The attachment of the placenta is easily detected by its dark colour, and by the semilunar openings of the arteries and veins on the surface of the uterus.

Of course, all the appearances just described will be greatly modified by the time that has elapsed between delivery and death.

Table showing the Size of the Uterus at different periods after Delivery.

Two to three days.—About seven inches long and four wide.

Seven days.—Between five and six inches long and two wide.

Fourteen days.—From four to five inches long and one and a half wide.

Twenty-eight days.—Normal size.

C. *Signs of a previous Delivery.*

a. Marks on the abdomen, consisting in shining silvery lines, due to the distension of the skin. These may result from distension other than that the result of pregnancy—tumours, dropsy, etc.

b. Marks similar to those on the abdomen appear on the breasts. These, in conjunction with the above, are important.

c. Peculiar jagged condition of the *os uteri* felt by the finger. This condition may be the result of disease.

d. Marks of rupture of the fourchette or perineum.

e. Dark colour of the areola round the nipples.

f. Negative evidence from absence of any of the above.

FŒTICIDE, OR CRIMINAL ABORTION.

Statute 24 & 25 Vict. c. 100, s. 58.—*Every woman, being with child, who, with intent to procure her own miscarriage, shall unlawfully administer to herself any poison or other noxious thing, or shall unlawfully use any instrument, or other means whatsoever, with the like intent, and whosoever, with intent to procure the miscarriage of any woman, whether she be or be not with child, shall unlawfully administer to her, or cause to be taken by her, any poison or other noxious thing, or shall unlawfully use any instrument, or other means whatsoever, with the like intent, shall be guilty of felony, and being convicted thereof shall be liable, at the discretion of the court, to be kept in penal servitude for life, or for any term not less than five years, or to be imprisoned for any term not exceeding two years, with or without hard labour, and with or without solitary confinement.*

The 59th section of the same statute also takes into consideration the unlawfully supplying or procuring any poison, or other noxious thing, or instrument, or

thing whatsoever for a woman, for the purpose of inducing abortion. The person so doing shall be guilty of a misdemeanour, and be kept in penal servitude for a term of five years, or to be imprisoned for any term not exceeding two years with or without hard labour.

It will be seen from the passages above quoted that there is no distinction between a woman *quick* or not *quick* with child. 'The offence is, to procure the miscarriage of *any woman, whether she be or be not with child.*'

The term *abortion* is understood in *medicine* to mean the expulsion of the contents of the fœcundated uterus before the sixth month of pregnancy, that is, before the child is considered viable. After this period it is said to be a premature labour. *In law*, however, no distinction is made, and the expulsion of the contents of the uterus at *any* period before the full time of pregnancy is considered an *abortion*; in popular language, a *miscarriage*.

Abortion, when not produced by criminal means, generally occurs at or a little before the *third month* of utero-gestation, and then usually in first pregnancies, or during the latter part of the period of child-bearing. It is also more frequent among the rich than among the poor.

Of the two thousand cases of pregnant women examined by Dr. Whitehead of Manchester, the sum of whose pregnancies was 8681, or 4·38 for each, rather less than 1 in 7 had aborted.

When abortion is criminally induced, it generally takes place between the *fourth and fifth month*, that is, about the time the woman becomes certain of her condition.

The causes of abortion are—

A. MATERNAL—belonging to the mother.

B. FŒTAL—belonging to the ovum.

C. VIOLENT.

a. Mechanical; b. Medicinal.

A. Maternal.

Among the maternal causes may be mentioned excessive lactation; any irritation of the rectum or bladder; loss of blood, which, by increasing the amount of carbonic acid in the blood, acts as an excitant to the spinal cord. Certain states of the system conduce to abortion — albumenuria, syphilis, certain fevers, scarlet, small-pox, etc. Abortion may become habitual in some women. Great joy or sudden sorrow have not infrequently been the cause of abortion. The tendency to abortion is greatest at the menstrual periods, that is, at the time when, had not the woman become pregnant, menstruation would have taken place. Slight causes acting at these times are very liable to produce abortion.

B. Fœtal.

Death of the ovum, or a diseased condition of its uterine coverings, or of the placenta, probably of an inflammatory nature.

C. Violent.

a. Mechanical.—Under this head may be mentioned the passage of certain instruments into the cavity of the womb; the rupture by violence of the membranes which surround the fœtus. In some cases it is by no means easy to procure abortion, and women have been known to undergo a considerable amount of violence without abortion taking place. In some women, on the other hand, however, the slightest violence—such, for instance, as slipping from a step or low chair—will cause them to abort.

b. Medicinal.—Certain drugs, among which may be mentioned ergot, savin, pennyroyal, and a host of others, have been used for the induction of abortion.

It is scarcely necessary to mention each drug individually, but it must be remembered 'that there is *not one single internal medicament* of which it can be consistently with experience asserted, that even when an abortion has followed its use, it must have produced this abortion, and that cause and effect are in such a case in direct and necessary connection.' All the so-called *abortives* are most uncertain in their action, and their use is attended with considerable risk to the woman. Be this as it may, they are more frequently used to induce abortion than mechanical procedure, from the fact that the latter requires some amount of anatomical knowledge and manipulative skill.

A medical man may be required to

a. Examine into the Nature and Character of the Substances expelled from the Womb.

b. Examine the Female supposed to have aborted.

a. The substances expelled from the womb often become the subject of judicial inquiry, and the medical man may be required to give his opinion as to their probable nature.

The questions may be asked—

1. Is it a fœtus?
2. Is it a mole? If so, Is a mole also a fœtus?
3. Is it merely the coats of the uterus, and unconnected with pregnancy?

1. *Is it a Fœtus?*—The development of the fœtus is given, page 94.

2. *Is it a Mole?*—This question gives rise to another, Is a mole a fœtus? To this the answer must be in the affirmative. Moles vary in character, and have been described by obstetrical writers under the following heads:—Hydatiginous, Carneous, and Fatty Moles.

3. *Is it merely the Coats of the Uterus, and unconnected with Pregnancy?*—Fleshy masses may be expelled from the womb, which may not be the result of sexual intercourse. The examination of the woman will help in

the formation of the diagnosis. The absence of the signs of defloration or of recent delivery will be in her favour.

b. Examination of the Woman stated to have aborted.—It is by no means easy to answer the question whether an alleged abortion has really taken place or not. The signs of recent delivery are in most cases absent, for the woman can better hide her condition during the early than during the latter months of utero-gestation; consequently suspicion may not have been aroused against her for some weeks or months after the event. The history of the case, with other attendant circumstances,—milk in the breasts, change in the colour of the areola round the nipples, absence of the hymen, transverse condition of the *os uteri* in contradistinction to its circular form after delivery, etc. etc.,—will in most cases assist in forming a correct diagnosis.

CRIMINAL ABORTION.

Recapitulation.

In medicine, abortion occurs before the sixth month of pregnancy, premature labour after that period.

In law, abortion may take place any time before the full period of utero-gestation.

Abortion may be due to—

a. Natural or unavoidable causes.
b. Violence, with criminal intent.

a. Natural or Unavoidable Causes.

1. Maternal.
2. Fœtal.

b. Violence, with Criminal Intent.

1. Mechanical.
2. Medicinal.

INFANTICIDE.

Synopsis.

a. Not regarded as a specific crime.

b. To be tried by the same rules of evidence as apply to murder.

c. The law presumes that every child is born dead, till proof to the contrary is given.

d. Onus of proving live birth devolves on the prosecution.

e. The body need not be found, in order to obtain conviction of the suspected party.

f. In absence of proof of infanticide, the woman may be tried for *concealment of birth*, that is, disposing secretly of the body, whether the child be born dead or alive.

g. In Scotland, a woman may be tried for concealment of pregnancy when the child is dead or amissing, if she does not call for or make use of help or assistance in the birth; but the case is quashed if a live child be produced.

Legal Definition.—According to the present state of English law, infanticide—murder of a *new-born* child—is not regarded as a specific crime, but is treated and tried by those rules of evidence which are applicable in cases of felonious homicide. As far as the legal estimation of the crime is concerned, it matters not whether the child has been killed immediately on its entrance into the world or a few days afterwards. The law also, on the score of humanity, presumes that every child is born dead, until direct evidence to the contrary, from medical or other sources, is given. The onus of the proof of live birth, therefore, devolves on the prosecution. The discovery of the body of the child is not necessary to conviction. In most cases

of alleged infanticide tried in England, juries appear more inclined to fall back on the minor offence, *concealment of birth*, than to convict of the capital offence.

In Scotland, *concealment of pregnancy* is a statutory crime, chargeable when the child born is found dead or amissing, and there is no proof of its having been murdered. Pregnancy up to a period when a child might be born alive must be proved. If the accused can bring forward a witness to whom she communicated her pregnancy, or called for assistance at the birth, or (it is believed) can prove that the child was born dead, she is entitled to an acquittal. The punishment is imprisonment not exceeding two years.[1]

Definition of the Term 'Live Birth.'—'The entire delivery of a child.' There must be an independent circulation in the child before it can be accounted alive (*R.* v. *Enoch*). But the fact of the child being still connected with the mother by the umbilical cord will not prevent the killing from being murder (*R.* v. *Reeves*, 9 C. and P. 25). To kill a child in its mother's womb is no murder, because the person killed must be 'a reasonable creature in being, and under the king's peace.' But if the child be injured in the womb, and be then born alive, and then die as a result of such injuries, it may be murder in the person who inflicted them.

A distinction must be drawn between *medical or physiological life* and *legal life*. A child may have breathed, as it not infrequently does, *before* it is completely born into the world; and this might, in a medical point of view, be considered as a live child, but it is not one legally. The entire delivery of the child is necessary in law; and 'it must also be proved that the entire child has actually been born into the world in a living state, and the fact of its having breathed is not a conclusive proof thereof.'

[1] Burton's *Scotch Law*.

Signs of Live Birth prior to and independent of Respiration.

a. Negative.—Signs of intra-uterine death; Putrefaction.

b. Positive.—Injuries to the child showing that it must have been born alive.

a. Negative.—*Intra-uterine Putrefaction.*—This condition differs in some remarkable points from putrefaction in air.

The body is extremely flaccid and flattened, the bones of the cranium moving easily on one another. The skin of the hands and other parts of the body bear the evidence of prolonged soaking in fluid. In parts, the skin is whitish, or of a reddish brown or coppery red colour, without any trace of green, which is always present when putrefaction takes place in the air. The cuticle may be raised in blisters, and be easily detached from the true skin. The denuded patches are moist and greasy, and exude a stinking reddish-coloured serous fluid. The face is flattened, and the features distorted. Should, however, the child be exposed to the air, it may soon acquire the appearances proper to putrefaction in that medium.

b. Positive.—Evidence that injuries found on the body could not have been inflicted during birth, or accidentally after birth. On this subject it is scarcely possible to give an opinion one way or the other.

APPEARANCES SHOWING THAT A NEW-BORN CHILD HAS BREATHED.

1. *Walls of the Chest.*—'The vaulting of the thorax is of not the slightest diagnostic value.' Casper quotes from Elsässer the following remarks: 'It is irrefutable that the variations in the circumference of the thorax (and, of course, in its diameters) are

so considerable, that no certain normal mean for a thorax that has breathed, and for one that has not breathed, can be laid down. In most cases, the measurements of the thorax are incapable of determining whether the lungs contain air or not. The reason for these variations is, without doubt, to be referred to the congenital differences in the volume of the osseous thorax; partly, also, to the thickness of the soft parts, particularly of the subcutaneous fat and the thoracic muscles; partly, also, in the differences in the degree and amount of the dilatation of the thorax by respiration, with which the distension of the lungs also corresponds,' etc.

2. *Diaphragm.*—The position of the diaphragm may be considered as a good diagnostic sign; for it is found that, in children born dead, the highest point of the concavity is between the fourth and fifth ribs, whereas in those born alive it is between the fifth and sixth. The position of the diaphragm may be affected by the gases produced during putrefaction, and also in children who have *breathed*, from distension of the stomach and intestines with gas.

3. *Lungs.*

a. Size.—In the fœtus, prior to respiration, the lungs do not fill the cavity of the chest, and the left lung is never found even partially covering the heart.

After respiration they fill the thorax more or less completely, the amount of distension depending, of course, upon the completeness of the respiratory acts on the part of the child.

b. Consistence.—Before respiration has taken place, the lungs feel firm, compact, and resistent, and are of the consistency of liver.

After respiration they are spongy, crepitant, and yielding when pressed between the fingers. These signs of respiration are more or less modified by disease, and the *atelectasis pulmonum* of Jörg, jun.

Casper denies the existence of *atelectasis pulmonum*

as a distinct disease of newly-born children, and considers that 'it is nothing else than the original fœtal condition, from which it differs in no anatomical respect.' It is simply the result of the child dying from some cause before respiration has had time to become fully established, and has possibly been confounded with hepatization.[1]

c. Colour.—The colour of the fœtal lungs is 'exceedingly various,' and it is by no means easy to convey the idea of colour by words. Speaking in general terms, the lungs of children who have *not* breathed are of a reddish-brown liver colour, this colour changing to a brighter red at their margins. In children who *have* breathed, the lungs are of a slaty-blue colour, more or less mottled with circumscribed red patches. This circumscribed mottling is *never* found in perfectly fœtal lungs. When the lungs are inflated artificially, they swell up and present an uniform cinnabar-red colour, destitute of insular marbling. The insular marbling of the lungs is characteristic of lungs that have breathed.

d. Buoyancy in Water.—Lungs which have respired float in water. But the objection may be raised that lungs that have *not* respired may yet float from—

a. The result of artificial respiration.

b. The result of putrefaction.

The value of these objections will be discussed in the following pages.

HYDROSTATIC LUNG TEST (*Docimasia pulmonum hydrostatica*).

The value of this test is founded on the supposition that a lung in which respiration has taken place will float if placed in water, and that when this has not occurred it will sink. Admitting that a lung floats

[1] For a full discussion on this subject, see Casper, vol. iii. p. 54 et seq., Syd. Trans.

as a result of respiration, it has been objected that this is no proof of live birth, for respiration may take place in—

a. The womb.

b. The maternal passages.

c. Cases when the head protrudes, the body not yet being born.

With regard to the two first objections, it will be sufficient to say that, in all the cases of so-called intra-uterine respiration, the respiratory acts have occurred in difficult or instrumental labours, where it is justifiable to suppose that, in the endeavour to remove the child, a certain amount of air may have been unavoidably admitted into the maternal passages. But the cases with which the medical jurist has to deal cannot be classed with these, for in all those brought under his notice delivery has been more or less rapid and unassisted.

To the last objection the same reply may be given, that rapid delivery in doubtful cases must be considered as the rule, and that the time which elapses between the birth of the head of the child and its complete delivery is so short as not to lead to any great error in diagnosis.

N.B.—Any pressure exerted on the umbilical cord during the process of delivery gives rise to respiratory acts on the part of the fœtus. The presence of what Casper calls *petechial ecchymoses* beneath the pleuræ, upon the aorta, and even on the heart, is a proof that attempts at respiration have been made. These petechial ecchymoses are sometimes found on the same parts in the drowned.

What is the Hydrostatic Test? how is it performed? And what are the Objections to its use?

As this test was first used, it consisted in placing the lungs, with or without the heart, into water, and then noting whether they sank or floated. To this

rough test pressure is now added, the lung, or portions of it, is greatly compressed in a linen cloth, and then thrown into water as before. If the lungs thus compressed float, respiration is held to have taken place; should they sink, the contrary is presumed.

1. Try if lungs will float, the heart attached to them.
2. If they will float without the heart.
3. Try if portions will float, with or without pressure.

The following are the objections to this test:—

1. The lungs may sink as a result of disease.
2. Respiration, even in healthy lungs, may be so imperfect that they may sink.
3. Emphysema pulmonum neonatorum.
4. Putrefaction.
5. Artificial inflation.

1. That in consequence of disease the entire lungs or portions of them may sink, and yet respiration had taken place. Disease of the lung may occur previously to birth or soon afterwards, but it is scarcely probable that the disease should attack every portion of the lung. Parts, doubtless, small in proportion to the diseased part, may yet have been sufficiently inflated to float. The presence of disease is also not difficult of detection.

2. That respiration, even in healthy lungs, may be so imperfect that they may sink. This objection can scarcely be considered valid against the general application of the test, for in these cases there is no known test by which respiration or its absence can be determined. They are therefore out of the pale of the test, as they are out of every other mode of investigation.

3. *Emphysema pulmonum neonatorum.*—Emphysema is generally the result of excessive dilatation of the air cells of the lung, rupture of their cell walls, and in-

filtration of the intra-lobular areola tissue. This condition may be brought about by—

a. Respiration. *b.* Inflation.

The fact of the matter is simply this, that the so-called *emphysema pulmonum neonatorum*, or emphysema of new-born children, is nothing more or less than incipient putrefaction, induced by certain unascertained conditions. Casper sums up his conclusions on this subject in the following words: '*That not one single well-observed and incontestable case of emphysema developing itself spontaneously within the lungs of a fœtus, born without artificial assistance, is known, and it is not therefore permissible in forensic practice to ascribe the buoyancy of the lungs of new-born children brought forth in secrecy, and without artificial assistance, to this cause.*'

4. *Putrefaction.*—It must be admitted as proved that the lungs of new-born children in a state of decomposition will float in water. But this admission does not render the test valueless, for it must be remembered that—

a. The lungs are among those organs which putrefy late.

b. Negative evidence may be obtained if the lungs in a highly putrescent body sink in water. The tendency of putrefaction, as above stated, is to cause them to float.

5. *Inflation.*—In the first place, it is to be remarked that to inflate the lungs is by no means an easy task. Elsässer states, 'that in forty-five experiments performed on children born dead, without opening their thorax and abdomen, only *one* was attended with complete success, thirty-four with partial success, and ten with none whatever; and it must also be remembered that these experiments were conducted without disturbance, and with the greatest care.' In the cases that come before the medical expert, the question naturally arises, Who would inflate the lungs? Surely not the mother, who would be only too glad that the

child was dead, and who would be in no hurry to resuscitate it. If not the mother, who else?

The following points may be noticed on this subject:

a. Known difficulty in inflating the lungs.

b. Absence on the part of the mother of any preparation to save the life of her child.

c. Presence of air in the stomach and intestines, the result of attempted inflation.

d. Bright cinnabar-red colour of the lungs, without trace of mottling.

e. Absence of frothy blood when the lungs are cut into.

f. 'When, therefore, we observe the following phenomena, a sound of crepitation, without any escape of blood-froth on incision, *laceration* of the pulmonary cells with hyperæria, bright cinnabar-red colour of the lungs *without any marbling*, and perhaps *air* in the (artificially inflated) stomach and intestines, we may with certainty conclude that the *lungs have been artificially inflated*.'

The objections just mentioned apply to the hydrostatic test, as originally employed. It will now be necessary to notice those against the same test when modified by pressure. These are two in number:—

a. That no amount of pressure, short of entirely destroying the lung tissue, can expel the air from a lung that has been inflated, or from one in which respiration has taken place.

b. Pressure is therefore no test of natural respiration, or of artificial inflation.

In answer to the above, it will be only necessary to refer to what has been already said with regard to the difficulty of inflation, and the more probable event of the condition of the lungs being the result of respiration.

Casper thus sums up the result of his views with regard to the probative value of the Docimasia Pul-

monaris: 'That a child has certainly lived during and after its birth—

'1. When the diaphragm stands between the fifth and sixth ribs;

'2. When the lungs more or less completely occupy the thorax, or at least do not require to be sought for by artificial separation of the walls when cut through;

'3. When the ground colour of the lungs is broken by insular marblings;

'4. When the lungs are found by careful experiment to be capable of floating;

'5. When a bloody froth flows from the cut surface of the lung on slight pressure.'

The lung test is unnecessary, when—

a. The umbilical cord has dropped off, and cicatrization has followed.

b. Where food is found in the stomach.

c. Where there are evident signs of putrefaction *in utero.*

d. Also in the case of the birth of monsters, or where, from congenital malformation, the possibility of live birth is excluded.

Besides the hydrostatic test, the following have been proposed, and may be dismissed in a few words:—

Ploucquet's Test.—This test is based on the relative weight of the lungs, before and after respiration, to that of the entire body of the child. The variations found in practice between the relative weights render the test worse than useless.

Absolute Weight of the Lungs.—This test consists in a comparison of the weight of the lungs before and after respiration. Like the last, it is unworthy of confidence.

Table showing the Development of the Embryo according to the Lunar Months.

MONTH.	LENGTH.	WEIGHT.	OBSERVATIONS.
First. (Third or fourth week.)	Four to six lines.	Twenty grains.	The embryo is curved; the mouth on the cephalic extremity appears as a cleft, and the eyes as two black points. Nipple-like protuberances mark the position of the extremities. The heart can be seen, and the liver is disproportionably large.
Second. (End of eighth week.)	Fifteen to eighteen lines long.	Two to five drachms.	The head disproportionably large. Nose, lips, and external parts of generation visible. Arms appear as a dark point. Abdomen encloses the internal organs. Extremities project slightly from the trunk. *Ossification* in *clavicle* and *lower jaw* about end of *seventh week*; in *frontal bone* and *ribs* towards end of *eighth week*.
Third. (End of twelfth week.)	Two inches to four inches.	One ounce to two.	Eyes and mouth closed. Fingers well separated; nails recognisable. The sex can be detected by the aid of a lens. Supra-renal capsules and thymus gland are formed. The

			cavities of the heart and divisions of the brain distinct. The placenta isolated; the umbilical vesicle, allantois, etc., have disappeared.
Fourth. (End of sixteenth week.)	Five to six inches long.	Two and a half to three ounces.	The skin rosy and tolerably dense. Sex seen without aid from lens. The mouth is large and open; the umbilicus is near the pubis. Meconium of a greyish-white colour in the large intestines.
Fifth. (End of twenty weeks.)	Ten to eleven inches long.	Seven to ten ounces, varying in individuals.	From the fifth month the length of the fœtus in inches is approximately *exactly double the number of the lunar months.* The nails are distinct. The head, liver, heart, and kidneys are disproportionately large. The hair appears as a light down. The meconium is of a yellowish-green colour. Points of ossification, pubis and os calcis.
Sixth. (End of twenty-fourth week.)	Twelve to thirteen inches in length.	One to two pounds.	Down and sebaceous matter cover the skin. The colour of the body is a cinnabar red, and the umbilicus is farther from the pubis. The meconium is darker in colour; and the scrotum is empty, the testis being close to the kidneys. The pupillary membrane is still present.

MONTH.	LENGTH.	WEIGHT.	OBSERVATIONS.
Seventh. (End of twenty-eighth week.)	Fourteen to fifteen inches.	Three to four pounds.	The skin is of a dirty red colour; the hair about half an inch long, and plentiful. Membrana pupillaris disappearing; eyelids non-adherent. The large intestine quite full of dark, olive-green meconium. Fontanells distinctly felt. Liver still large, of a dark-brownish colour.
Eighth. (Thirty-second week.)	Fifteen to sixteen inches.	Three to five pounds.	Skin, covered with soft hair, is more of a rosy flesh colour. Disappearance of the pupillary membrane, and descent of the testicles into the scrotum. The open vulva expose the clitoris to view. The nails almost reach the tips of the fingers.
Ninth. (End of thirty-sixth week.)	Sixteen to eighteen inches.	Six pounds.	Head covered with hair, the down on the body disappearing. The scrotum corrugated, and the vulva closing.
Tenth. (Forty weeks.)	Eighteen to twenty inches.	Seven to nine pounds.	Well-known signs of maturity.

Table showing Signs of Maturity of Child at Birth.

As regards—

a. Average Length of Body—
Nineteen inches.

b. Average Weight of Body—
About seven pounds.

c. Eyes—
The pupillary membrane is not found in the mature child.

d. Navel—
Said to be exactly midway between the pubis and the ensiform cartilage.

e. External Genitals—
Testicles found in the scrotum, and the labia majora cover the vagina and clitoris.

f. Os Femoris—
Ossification of the inferior femoral epiphysis. The osseous nucleus measures from three-quarters to three lines in diameter.

[TABLE OF MEASUREMENTS.

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Table giving the Measurements, according to the Months, of the Extremities of the Fœtus in the order of their development.

	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Full Period.
Humerus . .	3½ lines.	8 lines.	13–15 lines.	16 lines.	20–22 lines.	23–24 lines.	3 inches.
Radius . .	2½ "	8 "	12 "	16 "	17 "	18–19 "	2 " 8 lines.
Ulna . .	3 "	8 "	13 "	17 "	18 "	22–23 "	2 " 10 "
Femur . .	2–3 "	4–5 "	12 "	17 "	19–21 "	24 "	3 " 6 "
Tibia . .	2–3 "	4–5 "	12 "	17 "	19–21 "	21–23 "	3 " 2 "
Fibula . .	2½ "	...	12 "	17 "	19–21 "	21–23 "	3 " 1 "

Table showing the Maximum and Minimum Dimensions of the Osseous Nucleus of the Inferior Femoral Epiphysis from the Seventh Month of Intra-Uterine Life to Two Years after Birth.

	Intra-uterine.			Extra-uterine.						
				Days.			Months.			
	Seventh.	Ninth.	Mature.	1–8.	9–15.	16–28.	1–2.	3–6.	7–12.	12–24.
Maximum . .	...	2 lines.	4 lines.	3½ lines.	3½ lines.	2½ lines.	5 lines.	4 lines.	8 lines.	7 lines.
Minimum . .	...	...	¾ "	1 "	¾ "	1½ "	2 "	2 "	3 "	5 "
No. of children examined, 124	31	9	51	8	3	2	9	3	6	2

CAUSE OF DEATH TO THE FŒTUS.

Death may be due to—

a. Immaturity on the part of the fœtus.

b. Complications occurring during or immediately after birth.

c. Congenital disease in one or more of the fœtal organs.

a. Immaturity on the part of the Fœtus.—From some cause or other, the child may die immediately after birth, in spite of every attempt to save it. In many of these cases no disease adequate to account for death can be detected.

b. Complications occurring during or immediately after Birth.

1. Unavoidable or inherent in the process of parturition.
2. Induced with criminal intent.

1. *Unavoidable or Inherent in the Process of Parturition.*—The immediate cause of death may be either maternal or fœtal. In the former, the presence of tumours in the pelvic passages, or disease of the bones, causing a narrowing of the canal, may lead to fatal compression of the head of the child. In the latter, pressure on the umbilical cord from mal-position of the child during labour, or an abnormal increase in the size of the head, may cause death. There is also a greater mortality both during and after delivery among male than female children. The child may be also accidentally suffocated in the fæces of the mother, or in a fold of her dress; or it may be born while the woman is straining at stool, and be drowned in the contents of the pan. The writer once met with a case of accidental death of a child from suffocation in the drawers of the mother, who persisted, from motives of *delicacy* (?), in wearing during her confinement these articles of dress. Death may also result from strangulation, occasioned by the pressure of the funis round

the child's neck. Lastly, death may ensue from falls on the floor in cases of sudden and quick labours, especially if the woman be in the erect posture at the time of delivery.

2. *Induced with Criminal Intent.*—Was the death due to violence? The answer to this question is by no means easy. In all doubtful cases, the attendant circumstances must be taken into consideration. The presence of respiration more or less complete is strongly presumptive against the death being the result of accident. Foreign bodies found in the mouth and fauces is also corroborative of death by violence. The same may be said of strangulation and of injuries to the head. Strangulation may be produced by the constriction of the umbilical cord round the neck, and for this reason marks round the child's neck cannot always be ascribed to intentional violence. With regard to marks round the neck of a new-born child, Casper remarks that it is possible '*to mistake the folds of the skin, produced by the movements of the head, and which remain strongly marked in the solidified fat,* and are very prominent, particularly in short necks, for the marks of the cord.' The *mark* left by the *funis* is broad, corresponds with the breadth of the cord, runs without interruption round the neck, and is everywhere quite soft, and never excoriated. Ecchymoses may be present irregularly, following the line made by the cord. On the other hand, 'a mummified, parchment-like, unecchymosed depression, points in every case to strangulation by a hard rough body.' Death sometimes ascribed to strangulation is probably death the result of suffocation, and happens thus: any pressure exerted on the cord gives rise to respiratory attempts on the part of the child, the blood from the placenta is cut off, and the child dies suffocated.

Fractures of the skull may happen—

a. In the Womb.—The parturient female may fall

from a considerable height, and thus cause injury to her child. These cases are of no judicial importance.

b. During Labour.—Fracture of the cranial bones during labour generally occurs in difficult and protracted labours, which, from this very cause, seldom become the subject of judicial inquiry. In some cases the defective ossification of the bones of the skull may give rise to fractures, which may lead to dangerous mistakes. This deficiency in the process of ossification is thus described by Casper: 'If the bone in question is held up to the light, this is seen to shine through the opening, which is closed only by the pericranium. When the periosteal membrane is removed, the deficiency in the ossification is seen in form of a round or irregularly circular opening, not often more than three lines in diameter, though frequently less; its edges are irregular and serrated: these edges are *never depressed, as is the case in fractures;* and neither they nor the parts in their neighbourhood are ever observed to be ecchymosed.' The child in these cases may breathe for a short time, and then die without any apparent cause.

c. By Falls.—It is beyond doubt possible for a child to be born so precipitately as to fall on the floor and be severely injured, and that even fatally. In cases of alleged precipitate birth, to account for injuries found on the child, the following points should be remembered, and will assist in forming a diagnosis:—

1. *In favour of Precipitate Birth and Accidental Injury.*
    - *a.* Rupture of the umbilical cord.
    - *b.* Placenta not detached from the child.
    - *c.* Fracture of the parietal bones; the fracture radiating into the frontal and squamous portion of the temporal bone.
    - *d.* Imperfect ossification of the bones of the skull.
    - *e.* Absence of other injuries.

2. *In favour of Criminal Violence.*
   - *a.* The fact of the umbilical cord being divided by some sharp instrument, and not torn.
   - *b.* Extensive fracture of one or more of the bones of the cranium.
   - *c.* Fracture and dislocation of the neck.
   - *d.* Presence of incised wounds and other evidence of violence.

N.B.—In all doubtful cases a guarded opinion should be given, stating simply that the dissection does not reveal anything contrary to statement as to the cause of the death.

Has the Infant Bled to Death?—Fatal hæmorrhage from the cord may occur, especially if it be divided by a sharp instrument close to the body of the child. The signs of death from hæmorrhage have been noticed, page 30.

How long did the Child survive its Birth?—The answer to this question is by no means easy, and the data on which a decision can be based are not very reliable. The following are some of the points to be considered in forming a diagnosis:—

- *a.* Changes in the skin.
- *b.* Changes in the umbilical cord.
- *c.* Changes in the circulatory system.

a. Changes in the Skin.—Exfoliation of the cuticle. The time at which this occurs is so variable as to be of little value in a medico-legal inquiry.

b. Changes in the Umbilical Cord.—Mummification of the cord is not of the slightest value as a proof of extra-uterine life; but the separation of the cord which occurs between the fourth and seventh day, especially when cicatrization has taken place, is a sure sign that the child must have lived four or five days at least. Two other appearances of some value may also be noted, namely—

1. In fresh bodies, the appearance of a bright red

ring about a line in breadth, which surrounds the insertion of the cord, and which is formed within the uterus.

2. A similar red ring, about two lines broad, around the insertion of the cord, accompanied with '*thickening, inflammatory swelling of the portion of the skin affected, and slight purulent secretion from the umbilical ring itself.*' This latter condition Casper considers as affording '*irrefragable proof of the extra-uterine life of the child.*'

c. Changes in the Circulatory System.

1. *Ductus Arteriosus.*—Arterial duct. A contracted condition of this duct is of no value as a proof that a child has survived its birth; for the duct is liable to become contracted, and even obliterated, before the birth of the child.
2. *Ductus Venosus.*—Nothing certain is known as to the exact time when this duct closes; the condition of the vessel is therefore of no assistance in determining the possibility of the child having survived its birth.
3. *Foramen Ovale.*—What has been said of the preceding may be said with regard to the foramen ovale.

N.B.—To sum up, therefore, in the fewest words, any attempt at forming an opinion on the *docimasia circulationis* may result in a fatal error on the part of the medical witness, as it is impossible to determine with any accuracy by days the period of their closure. As a general statement, however, the following, according to Berut and Orfila, is the order in which obliteration of the fœtal vessels takes place:—1. The umbilical arteries. 2. Ductus venosus. 3. Ductus arteriosus. 4. Foramen ovale.

LIVE BIRTH.—The 'entire delivery of the child' has generally been considered in criminal law to constitute birth, but on this point the civil law of England

has not proffered a definition. Separation from the mother by cutting the umbilical cord does not appear to be necessary. In criminal cases, the entire body of the child must be without the body of the mother. But a child may be *alive at birth*, and yet *not born alive*, that is, part of the body may be born, and life, physiological life, be present; but *in law*, the child is not considered as *born alive* till it is free of the maternal passages. The inference unfortunately follows from this ruling, that a mother may kill her child without fear of punishment, if she does so before the entire body has slipped from her.

The evidence of live birth in civil, is somewhat different to that required in criminal cases. The viability of the child is determined in Scotland by its *crying;* in France, by its respiration; but in England the pulsations of the child's heart, or any tremulous motion of the muscles, however slight, has been considered as satisfactory proof of live birth.[1]

According to Blackstone, 'crying, indeed, is the strongest evidence, but it is not the *only* evidence;' and Coke remarks, 'If it be born alive it is sufficient, though it be not heard to cry, for peradventure it may be born dumb.' According to the common law of Germany, 'the LIVE BIRTH of a child is to be held proven when it has been heard to cry by witnesses of unimpeachable veracity present at its birth.'

A fœtus in the womb (*en ventre sa mère*) may—

a. Have a legacy or estate made over to it.

b. A guardian assigned to it.

That these conditions may take effect, it must be born alive.

c. Be an executor.

To exercise this *post-partum* function, the child must have attained the age of twenty-one.

[1] See case of *Fyshe* or *Fisher* v. *Palmer*, in 1806.

INHERITANCE.

This subject will be discussed under the following heads :—

a. The child must be born alive.

b. The child must be born during the lifetime of the mother.

c. The child must be born capable of inheriting.

d. Tenancy by courtesy.

a. The Child must be born alive.

This has been discussed in the preceding section.

b. The Child must be born during the Lifetime of the Mother.

Death terminates the marriage contract. Would a child born after the death of the mother, and therefore not during marriage, be entitled to inherit?

On this point Lord Coke writes: 'If a woman, seised of lands in fee, taketh husband, and by him is bigge with childe, and in her travell dyeth, and the child is ripped out of her body alive, yet shall he not be tenant by the curtesie, because the child was not born during the marriage, nor in the life of the wife; but in the meantime her land descended.' It appears from this that the husband is not entitled to the life-rent.

c. The Child must be born capable of inheriting.

Monsters cannot inherit according to law. Blackstone says: 'A monster which hath not the shape of mankind hath no inheritable blood,' and cannot therefore inherit; but if 'it hath human shape, it may be an heir.' Buffon classes monsters under three divisions—

a. Monsters by excess of organs.

b. Monsters by defect of organs.

c. Monsters by alteration or wrong position of parts.

d. Tenancy by Courtesy.

'When a man marries a woman seised of an estate of inheritance, and has by her issue *born alive*, which was capable of inheriting her estate; in this case, he shall, on the death of his wife, hold the lands for his life as tenant by the courtesy of England.'

In this case, proof of live birth, as before mentioned, is of the slenderest kind.

LEGITIMACY.

Every child born in wedlock is presumed to have the husband of the woman as its father; but this presumption may be denied for the following reasons:—

a. Absence or death of the reputed father.

b. Impotence or disease in the father, preventing matrimonial intercourse.

c. In the case of a premature delivery in a newly married woman.

d. Want of access.

e. The paternity of a child may be disputed when the woman marries immediately after the death of her husband.

In Scotland, a child is held to be legitimate if born ten lunar months after the death or absence of its alleged father; and the absence of the supposed father must continue till within six lunar months of the birth of the child, to prove its illegitimacy.

In the same country, a child born before marriage is rendered legitimate by the subsequent marriage of the parents. This is not the case in England.

A child born during wedlock is legitimate, although the date of conception may be before marriage. A child born after the death of its mother is held to be legitimate. A child may, as Taylor remarks, be conceived before marriage, and born after the death of

the mother, and yet be legitimate, though neither conceived nor born in wedlock.

The Code Napoleon prohibited the contraction of a second marriage until ten months after the death of the first husband; and this is also the case in Germany. The Anglo-Saxon law prohibited re-marriage for twelve months. In Britain, no time is fixed by law.

Duration of Pregnancy.—The consideration of this subject is of importance in its relation to the legitimacy of a child.

The natural period of human gestation is usually stated at forty weeks, ten lunar months, nine calendar, or 280 days. In Prussia, the period is extended to 302 days, and in the Code Napoleon to 300; in Scotland, ten months is held as the limit. The duration of human gestation is subject to considerable variation: in some females it is always protracted; in others, always premature. Several modes of calculation are adopted by women:—

a. Ascertained date of impregnation from one coïtus.

b. Supposed sensations of female at time of conception.

c. Suppression of the catamenia. This is open to the objection that causes other than that of impregnation may arrest them. The usual mode of calculation is from two weeks after the last menstruation, and the period so fixed is corrected by the time at which quickening occurs.

d. Period of quickening.

1. Quickening supposed when pregnancy is absent.
2. Pregnancy without quickening.
3. Variations in the time of its occurrence.

Whichever may be the mode of calculation adopted, it may be stated that, as a rule, the period of human gestation is from 275 to 280 days, and that cases of alleged pregnancy beyond 300 days must be received with considerable caution.

The pregnancy of the Countess of Gloucester was held, in the reign of Edward II., to be legitimate, although her husband had been dead one year and seven months at the date of the application.

Premature Births.—The question may be asked, At what period of gestation may a child be born viable, that is, capable of living and attaining to maturity? Seven months, or 210 days, is considered as the limit; but cases have been recorded of children born at six months being reared. The Roman law admitted the legitimacy of seven-months children.

Superfœtation.—This term is used to imply the conception of a second embryo in a woman already pregnant, and the birth of two children at one time, differing considerably in their maturity, or of two births, a considerable period of time elapsing between each. The possibility of this occurrence is somewhat doubtful. Churchill, in his work on Midwifery, writing on this subject, says: 'In conclusion, I would say, 1. That the theory of superfœtation is *unnecessary* to explain the birth of a mature fœtus and a blighted ovum, of a mature and immature fœtus born together, or within a month of each other, or of fœtuses of different colours, as they may reasonably be supposed to be the product of one act of generation, or of two nearly contemporaneous. 2. That, in cases of double uterus, it is possible for a second conception to take place, and (judging from the subsequent birth of the second child in the only case on record) at a later period than the first. 3. That in the remaining cases, where one mature child succeeded the birth of another after a considerable interval, we have no proof of a double uterus in any, and positive proof that in one case it was single; and that to the explanation of these cases no theory as yet advanced is adequate, that of superfœtation being opposed by physical difficulties which are insurmountable in the present state of our knowledge.'

IMPOTENCE AND STERILITY.

Impotence in the male may arise from—

1. Functional causes. 2. Organic causes.

1. *Functional.*—Excessive use of alcoholic stimulants, excessive venery, masturbation, and certain debilitating diseases.

2. *Organic.*—Malformation of the genital organs, deficiency of the penis, fistula in perineo, or malformation of the urethra—*hypospadias*—especially when the opening of the urethra is at a considerable distance from the glans. Absence of the testicles from the scrotum does not necessarily imply incapacity for procreation, for persons in whom the testicles were retained in the abdomen have been capable of begetting children. Cancer of the testicle, or the presence of any other organic disorganization of the gland, may be considered as a bar to procreation.

Sterility in the female may arise from—

1. Organic causes. 2. Functional causes.

1. *Organic Causes.*—Absence of the ovaries, uterus, or vagina; imperforate hymen; tumours in the vagina, etc. etc.

2. *Functional Causes.*—Extreme debility, though this is not always an impediment; for some weak, debilitated women conceive rapidly. Constant leucorrhœa may be a cause of sterility; so also may dysmenorrhœa, menorrhagia, and amenorrhœa.

To sustain an application for divorce on the ground of impotence, the cause or causes must have existed before marriage. A medical man may be required to ascertain the capability or incapability of a man for sexual intercourse in—

a. Cases of contested legitimacy.
b. Suits for divorce.
c. Accusations of rape.

SURVIVORSHIP.

The question of survivorship is not infrequently raised when a mother and her new-born infant are found dead, or where several persons have perished by a common accident.

In the first case, the mother is generally presumed to have lived longest; and this presumption may be borne out by the fact of the delivery being premature, or if there be considerable disproportion between the size of the child and the maternal passages. As pointed out before, important civil rights may depend upon the question as to the live birth of an infant; and the husband's right to be *tenant to the courtesy* will of course depend upon the view taken as to the probable survivorship or not of the child.

With regard to the second question, much will depend upon the relative ages and strength of the individuals. Sex will also have to be taken into consideration. In the case of one or more persons found dead, either from wounds or other causes, the fact of some being warm and others cold, the presence of the *rigor mortis* in one and absence in the other, will point to the probable survivorship. The severity of the wounds and injuries to large arterial trunks must also be considered.

MALPRAXIS AND NEGLECT OF DUTY.

A medical man is liable to a civil action for damages, who, by a culpable want of care and attention, or by the absence of a competent degree of skill and knowledge, causes injury to a patient. And it is

not necessary that the patient should have employed or was to have paid him, provided always that there be no negligence or carelessness on the part of the patient. A surgeon does not undertake to perform a cure, nor does he profess to bring the highest professional skill into the consideration of the case; but he does undertake to bring a fair and reasonable amount. 'So, if a physician or surgeon give his patient a potion or plaster to cure him, which, contrary to expectation, kills him, this also is neither murder nor manslaughter, but misadventure.' A medical man is only liable for gross negligence, not for every slip he may make; but the distinction between criminal and actionable negligence cannot be defined; but it appears that the negligence must be so gross as to come under the legal meaning of the word 'felonious.'

FEIGNED DISEASES.

Human ingenuity is not wanting among those who, for private ends, pretend to be suffering from disease. The soldier or sailor, anxious to escape the dangers of active service, finds a ready means of evading his duties by shamming; the prisoner, in order to lighten the burden of his punishment, does the same. A man declares himself impotent, to save the expense of keeping an alleged bastard child, or to avoid punishment for rape. Beggars appeal to the public by feigning some painful disease, and incautious benevolence becomes the dupe of the clever impostor.

Any attempt at classification is out of the question, nor does it appear necessary to give a long list of diseases which have been feigned, or the means that have been employed by artists in deception. To give some general hints for guidance, is all that will be attempted here, leaving matters of detail to the

acumen of the medical examiner, who, if in active practice, will have many opportunities of testing his powers of discernment.

1. Never be satisfied by one visit, but pay a second at a short interval, and unannounced.

2. Have the patient carefully watched in the interval of your visits.

3. Examine each organ of the body separately, carefully comparing the state of each with the symptoms described by the patient.

4. Note the discrepancies in the statements of the patient as to his symptoms, and their known occurrence in real disease.

5. Sometimes ask questions the reverse of his statements, or take his statements for granted, when in all probability he will contradict himself.

6. Remove all bandages and other dressings.

7. The administration of sham physic, or the suggestion of some heroic mode of treatment; the application of the actual cautery may have a beneficial effect.

8. Pay little attention to the reports of bystanders, or of the culprit's fellow-prisoners.

9. Anæsthetics may be employed, if necessary, for the purposes of detection.

10. The motives for deception should be inquired into, and borne in mind, in the exanination of all cases.

EXEMPTION FROM PUBLIC DUTIES.

The existence of certain diseases may be claimed as a bar to active service, both in a civil and military capacity; and the opinion of a medical man may be required as to the fitness or unfitness of the individual for the service from which he claims exemption. In giving certificates of this nature, the medical practitioner cannot be too guarded in wording them; and

each case must be treated on its merits, so that strict justice may be done.

Among the diseases which may incapacitate a man for active employment, may be mentioned—syphilis; hernia; phthisis; affections of the eyes, attended with dimness of vision; varicose veins, and some other diseases. For the army, a man is not considered fit for active service until he is twenty-one years of age.[1]

MENTAL UNSOUNDNESS.

In the whole range of medical jurisprudence there is no subject more interesting, more difficult, or more important, than the diagnosis of insanity, and its relation to the criminal responsibility of individuals. It is impossible, in the short space at our disposal, to do more than to offer a few remarks which may assist the student in the elucidation of some of the most important cases which may engage his attention.

As laid down by English lawyers, madness absolves from all guilt in criminal cases. Where the deprivation of the understanding and memory is total, fixed, and permanent, it excuses all acts; so, likewise, a man labouring under adventitious insanity is, during the frenzy, entitled to the same indulgence, in the same degree with one whose disorder is fixed and permanent. *Beverley's case*, Co. 125, Co. Litt. 247, 1 Hale 31.[2] 'But the difficulty in these cases is to distinguish between a total aberration of intellect and a partial or temporary delusion merely, notwithstanding which the patient may be capable of discerning right from wrong; in which case he will be guilty in the eye of the law, and amenable to punishment.' Lord Hale, who first pointed out the distinction to be drawn between total and partial insanity, offered the

[1] See Aitken's *Growth of the Recruit and Young Soldier*.

[2] Archibold's Criminal Cases.

following as the best test he could suggest: 'Such a person as, labouring under melancholy distempers, hath yet as great understanding as ordinarily a child of fourteen years hath, is such a person as can be guilty of treason or felony.' On this subject see *R.* v. *Ld. Ferrers*, 19 St. Tr. 333; *R.* v. *Arnold*, 16 St. Tr. 764, etc.

To excuse a man from punishment on the ground of insanity, it appears that it must be distinctly proved that he was not capable of distinguishing right from wrong, and that he did not know, at the time of committing the crime, that the offence was against the laws of *God* and *nature*. *R.* v. *Offord*, 5 C. and P. 186.

Mere moral insanity—where the intellectual faculties are sound, and the person knows what he is doing, and that he is doing wrong, but has no control over himself, and acts under an uncontrollable impulse—does not render him irresponsible. *R.* v. *Burton*, 3 F. and F. 772. The fact of the sanity or insanity of the prisoner at the time the crime was committed is left to the jury to decide, guided by the previous and contemporaneous acts of the party.

For some valuable remarks on the subject of the irresponsibility of madmen, the student is referred to the works of Prichard, Ray, Hoffbauer, Georget, and others.

The following suggestions are offered for consideration on this subject :—

a. Was the act an isolated event in the life of the culprit? has it the appearance of spontaneity, or was it the culminating point of a life spent in criminal acts?

b. Absence of a motive for the committal of the deed. The absence of an *apparent* motive is no proof of an unsound mind; the moving principle may be '*the conscious impulse to the illegal gratification of a selfish desire.*'

c. The presence or absence of a well-concerted plan of action is a diagnostic sign of little value. Casper remarks, that 'only in one case can the examination of the systematic planning of the deed afford any information, and that is when these plans and preparations themselves evince the stamp of a confused intellect, and betray the hazy consciousness, the mental darkness, in which the culprit was involved.'

d. A dominant delusion may be so concealed as to be for a time undiscoverable.

The case of the man who gave no indication of his madness till he was asked to sign the order for his release, when he signed *Christ*, is an example how carefully a delusion may be concealed even during a most careful examination. Questions directed to this point showed that he laboured from all the errors which such a delusion might suggest.

e. It may 'easily be conceived that insane persons, whose unreason affects only one train of thought more or less restricted, yet labour in other respects under disorders of feeling which influence their conduct and their actions and behaviour, without materially affecting their judgment; and that many of such deranged persons, who often conduct themselves tolerably well in a lunatic asylum, and while living among strangers, with whom they have no relations, and against whom they have no prejudices or imaginary reason of complaint, subjected besides to the rules of the house, and to an authority that nobody attempts to dispute, would nevertheless, if restored to liberty, and residing in the midst of their families, become insupportable, irritable at the slightest contradiction, abusive, impatient of the least remark on their conduct, and liable to be provoked by trifles to the most dangerous acts of violence. If, under such circumstances, a lunatic should commit any act of injury or serious damage to another, would it be just to punish him, because it cannot be made apparent that the action

has any reference to or connection with the principal illusion which is known to cloud his judgment, it being apparent that his moral faculties have undergone a total morbid perversion?'

f. Insanity with lucid intervals. Haslam, Ray, and others appear to deny the possibility of lucid intervals; but M. Esquirol, on the other hand, fully recognises the existence of this form of insanity. In civil cases the law recognises the validity of wills made during lucid intervals, and has even taken the reasonableness of a will as a proof of a lucid interval.

g. Have measures been taken by the culprit to escape punishment?

The classification adopted here is that given by Ray, and is sufficient for all practical purposes.

- Insanity.
  - Defective development of the faculties.
    - Idiocy.
      1. Resulting from congenital defect.
      2. Resulting from an obstacle to the development of the faculties supervening in infancy.
    - Imbecility.
      1. Resulting from congenital defect.
      2. Resulting from an obstacle to the development of the faculties supervening in infancy.
  - Lesion of the faculties subsequent to their development.
    - Mania.
      - Intellectual—
        1. General.
        2. Partial.
      - Affective—
        1. General.
        2. Partial.
    - Dementia.
      1. Consecutive to mania, or injuries of the brain.
      2. Senile, peculiar to old age.

DEFECTIVE DEVELOPMENT OF THE FACULTIES.

Idiocy. Cretinism. Imbecility.

Idiocy.—Idiocy is congenital, and was defined by Esquirol thus : Idiocy is not a disease, but a condition in which the intellectual faculties are never manifested, or have never been developed sufficiently to enable the idiot to acquire such an amount of knowledge as persons of his own age, and placed in similar circumstances with himself, are capable of receiving. Idiocy commences with life, or at an age which precedes the development of the intellectual and affective faculties, which are from the first what they are doomed to be during the whole period of existence. Since the days of Esquirol much improvement has been made in the care and treatment of the idiot; and it appears that he is capable of some, though in most cases slight, mental culture. The cases where improvement takes place probably belong to imbecility, leaving the *idiot* in the same condition as described by Esquirol.

Cretinism differs from idiocy in being endemic; it is also more curable, or at least more susceptible of improvement, than the latter. In the idiot the malady is congenital; the cretin, on the other hand, may to all appearances for a time be free from disease. 'Every cretin is an idiot, but every idiot is not a cretin; idiocy is the more comprehensive term, cretinism is a special kind of it.' The enlarged thyroid gland, high-arched palate, and brown or yellow colour of the skin, are characteristic of the cretin. Local causes seem to be at work in the production of cretinism; but what the exact nature of these causes is, has not been definitely settled. It has been attributed to miasma, to overcrowding in low-lying, badly ventilated houses, and to ill-assorted marriages. Smallness of the brain, premature ossification of the cranium, and want of

symmetry in the brain, have also been mentioned among the causes of cretinism.

The idiot is usually cunning, mischievous, and dirty in his habits.

The derivation of the word idiot from the Greek ἰδιώτης—*a private person*, or *an ill-informed ordinary fellow*—is peculiar. A person suffering from any form of mental unsoundness, and thereby rendered incapable of taking care of himself or of his property, was formerly called in English law 'an idiot,' and this word was not infrequently joined with 'fatuus' in old writs.

Imbecility.—This is a minor form of idiocy, and may or may not be congenital; it also admits of considerable degrees of intensity. Hoffbauer has divided imbecility (*Blödsinn*) into five degrees, and stupidity (*Dummheit*) into three.

Legal relations of Idiocy and Imbecility.—The legal definition of an idiot is 'one who is of non-sane memory from his birth by a perpetual infirmity, without lucid moments.' With regard to responsibility or irresponsibility of idiots and imbeciles, much will depend upon the degree of mental weakness present.

MANIA.

Mania is the result of a morbid condition of the brain, to express which, 'the term raving madness may be used with propriety, as an English synonym for mania. All maniacs display this symptom occasionally, if not constantly, and in greater or less degrees.' Like other diseases, mania observes the same pathological laws. There is a period of incubation, during which the true state of the patient is in most cases misunderstood, or not appreciated. Mental exaltation may exist from the first onset of the disease, or the attack may be ushered in by a stage of gloom or despondency. The general health shows signs of

impairment, the liver becoming sluggish, and the bowels confined or relaxed. In some cases, a febrile condition of the system is among the premonitory symptoms of an attack of mania. The physical health is not usually much affected during the paroxysm.

Dr. Conolly remarks, that 'even acute mania is not always accompanied by the ordinary external signs of excitement. It would seem as if we had yet to learn the real symptoms of cerebral irritation. Certainly, in recent cases of mania, — cases which have lasted more than six weeks, and in young persons in whom I have seen the maniacal attack pass into dementia,—I have known the most acute paroxysms of mania exist, rapid and violent talking, continual motion, inability to recognise surrounding persons and objects, a disposition to tear and destroy clothes and bedding, without any heat of the scalp or of the surface, without either flushing or paleness of the face, with a clean and natural appearance of the tongue, and a pulse no more than eighty or eighty-five.' This may occur in some cases, but in the majority there is always some amount of physical derangement; the system, however, gradually becoming tolerant of the undue excitement to which it is subjected.

Following the classification adopted, Intellectual Mania will now be briefly considered under its two divisions, *General* and *Partial.*

General Intellectual Mania.—The mind in this form of the disease is involved in the most chaotic confusion possible, and there is also considerable bodily derangement. The moral faculties become more or less affected, and the patient's social and domestic relations are greatly altered. At one time he is subject to violent fits of immoderate laughter, at another he is gloomy and taciturn; sometimes quiet and tractable, at others wild and excited, necessitating close confinement. He is haunted by wild delusions, which

at times take entire possession of him, and under the influence of which he acts in the most extraordinary manner. It may be as well to define in this place the difference between *a delusion* and *an illusion.*

A delusion is a chimerical thought; an affection of the mind.

An illusion is a perversion of the senses; a mockery; false show; counterfeit appearance.

A *delusion* of the mind, an *illusion* of the senses.

Partial Intellectual Mania.—The term *monomania*, first suggested by Esquirol, is now generally given to this variety of insanity. The patient, in the simplest form of this disorder, becomes possessed of some single notion, which is alike contradictory to common sense and to his own experience. Thus, he may fancy himself made of glass; and influenced by this idea, he walks with care, and in dread of being broken by contact with other bodies. In the case of an inmate at the City of London Asylum, the presence of a weasel in the stomach was stated by one woman. Esquirol mentions the case of a woman with hydatids in her womb, who believed that she was pregnant with the devil. Most of these strange fancies appear to be dependent on errors of sensation.

Monomaniacs are ready enough to declare their predominant idea, yet at times, and that without the occurrence of a lucid interval, they will as carefully conceal it. 'In the simplest form of monomania, the understanding appears to be, and probably is, perfectly sound, on all subjects but those connected with the hallucination. When, however, the disorder is more complicated, involving a longer train of morbid ideas, we have the high authority of Georget for believing that, though the patient may reason on many subjects unconnected with the particular illusion on which the insanity turns, the understanding is more extensively deranged than is generally suspected.'

MORAL MANIA.

Pinel first drew attention to this form of madness. Prichard defines it as 'consisting in a morbid perversion of the natural feelings, affections, inclinations, temper, habits, and moral dispositions, without any notable lesion of the intellect, or knowing and reasoning faculties, and particularly without any maniacal hallucinations.' It is divided into—

General Moral Mania. Partial Moral Mania.

General Moral Mania.—'There are many individuals,' says Prichard, 'living at large, and not entirely separated from society, who are affected in a certain degree with this modification of insanity. They are reputed persons of a singular, wayward, and eccentric character. An attentive observer will often recognise something remarkable in their manners and habits, which may lead him to entertain doubts as to their entire sanity; and circumstances are sometimes discovered on inquiry which add strength to this suspicion. In many instances, it has been found that an hereditary tendency to madness has existed in the family, or that several relatives of the person affected have laboured under other diseases of the brain. The individual himself has been discovered to have suffered, in a former period of life, an attack of madness of a decided character. His temper and disposition are found to have undergone a change, or to be not what they were previously to a certain time; he has become an altered man, and the difference has perhaps been noted from the period when he sustained some reverse of fortune which deeply affected him, or the loss of some beloved relative. In other instances, an alteration in the character of the individual has ensued immediately on some severe shock which his bodily constitution has undergone. This has been either a disorder affecting the head, a slight attack of paralysis, or some febrile or inflammatory complaint,

which has produced a perceptible change in the habitual state of his constitution. In some cases, the alteration in temper and habits has been gradual and imperceptible; and it seems only to have consisted in an exaltation and increase of peculiarities, which were always more or less natural and habitual. Persons labouring under this disorder are capable of reasoning, or supporting an argument upon any subject within their sphere of knowledge that may be presented to them; and they often display great ingenuity in giving reasons for the eccentricities of their conduct, and in accounting for, and justifying, the state of moral feeling under which they appear to exist. In one sense, indeed, their intellectual faculties may be termed unsound; they think and act under the influence of strongly excited feelings; and persons accounted sane are, under such circumstances, proverbially liable to error, both in judgment and conduct.'

For interesting cases of this form of madness, see Ray's *Jurisprudence of Insanity.*

Partial Moral Mania.—In the case of the unfortunate sufferers from this malady, one or two only of the moral powers are perverted. This division admits of several subdivisions.

Kleptomania.[1] — A marked propensity to theft. 'There are persons,' says Rush, 'who are moral to the highest degree as to certain duties, but who, nevertheless, lie under the influence of some vice. In one instance, a woman was exemplary in her obedience to every command of the moral law except one — she could not refrain from stealing. What made this vice more remarkable was, that she was in easy circumstances, and not addicted to extravagance in anything. Such was the propensity to this vice, that when she could lay her hands on nothing more valuable, she would often, at the table of a

[1] For some valuable remarks on this and on the following forms of madness, see Casper, vol. iv. Syd. Trans.

friend, fill her pockets secretly with bread. She both confessed and lamented her crime.'

Pyromania.—This consists in an insane impulse to set fire to everything—houses, churches, and property of every kind and description.

Erotomania and Nymphomania.—This is known as amorous madness, and consists in an inordinate and uncontrollable desire for sexual intercourse. The unfortunate victims of this disease often express the greatest disgust and repugnance for their conduct.

Homicidal Mania.—In this form of madness the propensity to homicide is very great, and in most cases uncontrollable. (See the case of Henrietta Cornier, given by Prichard, Ray, and others.)

The following suggestions may be of assistance in forming a diagnosis as to the existence or non-existence of this form of madness :—

1. Previous history of the individual.

   Melancholy, eccentric, morose, etc.

2. Absence of motive.

   Gain, jealousy, revenge, hatred, etc.

3. A number of victims are often sacrificed at one time.

   The murderer, on the other hand, seldom sheds more blood than is necessary for his success.

4. Proceedings of the murderer before and after the crime.

   Absence of attempts at concealment or escape on the part of the madman.

5. Character of the victims.

   Not infrequently, in the case of madmen, their victims are those whom, when sane, they loved most, and to whom they were most attached.

Suicidal Monomania, or the propensity to Suicide.—Much discussion has arisen on this subject. Suicide is not always the result of unsoundness of mind. Some, like M. Esquirol, are inclined to consider suicide as always a manifestation of insanity. In the

present day, the dislike of coroners' juries to bring in any other verdict but that of suicide whilst in a state of unsound mind is proverbial.

DEMENTIA, OR FATUITY.

Dementia consists in a failure of the mental faculties, not congenital, but coming on during life. 'A man,' says Esquirol, 'in a state of dementia is deprived of advantages which he formerly enjoyed. He was a rich man who has become poor. The idiot, on the contrary, has always been in a state of want and misery.' In this state there is always more or less incoherence, and maniacal paroxysms are not infrequent. In mania, incoherence may be present, but then it is characterized by sustained and violent excitement. In dementia, on the other hand, there is apparent torpor and exhaustion of the mental faculties. Closely allied to this form of mental unsoundness is that interesting disease known as 'general paralysis of the insane,' or perhaps a better term, *progressive paralysis of the insane*. It is considered by some to precede the psychical derangement, a contrary opinion being held by others. General paralysis may accompany any of the forms of mental derangement, but it is generally preceded by a stage of melancholy. As the paralytic affection becomes more marked, there is a concurrent loss of memory, incapability of mental association, and all sense of duty is lost; the patient becomes careless as to his person, and dirty in his habits. He expresses himself as possessed of great property, and boasts of the wonderful deeds that he can or has accomplished. Gradually he sinks into a state of complete mental and physical decay. He cannot give expression to his thoughts, and has to be fed, the food being pushed into his mouth.

Symptoms.—The symptom which first attracts the

attention, and which is perhaps the first in order of sequence, is a modification in the articulation. 'This is neither stammering nor hesitation of speech. It more closely resembles the thickness of speech observable in a drunken man. It depends upon loss of power over the co-ordinate action of the muscles of vocal articulation.' If the tongue be now examined, it will be found that when it is protruded it is not inclined to one side, but that it is tremulous, and is protruded and withdrawn in a convulsive manner. Griesinger was the first to call attention to the fact—and his statement has since been confirmed—'that this motory disorder is at the commencement not so much paralytic as convulsive in its nature.' The gait becomes unsteady, he walks stiffly, and stumbles over the slightest unevenness in the floor. Step by step the paralysis progresses, till at last the unfortunate sufferer takes to his bed, on which he may lie for some months. Sometimes, especially during the earlier stages, he may suffer from terrible delusions, from maniacal paroxysms, or from epileptic fits, the latter possessing certain peculiarities. The tongue during the fit is seldom bitten, which is so commonly the case in epilepsy; and the convulsions are not so general, being limited more to one side than the other. It is also remarkable that each fit is in most cases followed by an increase of the mental derangement.

Prichard recognises four stages of dementia or fatuity :—

First Stage.—Forgetfulness and impaired memory. This is common to old age. In most cases, passing events produced little if any impression, whilst the past is remembered with tolerable freshness.

Second Stage.—Incoherence and unreason, characterized by a total loss of the reasoning faculty.

Third Stage.—Incomprehension. The person so affected is quite incapable of comprehending the

meaning of the simplest question; and should he attempt to reply, his answer is generally remote from the subject.

Fourth Stage.—Inappetency. The animal instincts are lost. The unfortunate sufferer lives, and that is all, being scarcely conscious of life. Organic life is all that is left.

DELIRIUM TREMENS.

A temporary form of insanity, the result of excessive indulgence in spirituous liquors. The drunkard, under the effects of intoxication, 'can derive no privilege from a madness voluntarily contracted, but is answerable to the law equally as if he had been in full possession of his faculties at the time' (1 Hale 32; Co. Litt. 247). The intoxication of the defendant may be taken as a mitigating circumstance, showing that the deed was unpremeditated. A person rendered incapable of using his reason by intoxication brought about by others, is not liable for his actions.

Delirium.—Acts performed during attacks of certain diseases,—fever, sunstroke, etc.,—accompanied with delirium, do not render the individual liable to punishment; and wills made during the continuance of the disorder, if they contain no statement inconsistent with the known wishes and desires of the party during health, are valid, the law looking more to the good sense of the will as a proof of a lucid interval, than to the proved existence of such lucid interval.

Directions for signing Medical Certificates for the Restraint of the Insane.

a. In the case of pauper patients the signature of one medical man only is required, but the order must be signed by a Justice of the Peace, or by the officiat-

ing clergyman and the relieving officer of the parish in which the lunatic for the time being resides.

b. In all other cases—

1. The signatures of two medical men are required.
2. A relation or friend must also sign the order.
3. The medical men must not be in partnership, as principal and assistant, or have any direct or indirect interest in the patient or in his keeping.[1]
4. They must make separate visits, and at different times.
5. Each must write clearly in the proper place, on the form prescribed by law[2]—
   (*a*) The facts observed by himself, as evidence of insanity.
   (*b*) The facts observed by others as evidence of insanity. The name of his informer *must* be given.
6. The correct address of the patient and the date of the visit must be stated. The address of the certifying medical men must also be stated.
7. The certificate remains valid only for seven days.

Liabilities of Persons signing Lunacy Certificates.

In the case of *Nottidge* v. *Ripley and Nottidge*, the Lord Chief Baron having been understood to intimate an opinion that no person ought to be so confined unless he is dangerous to himself or others, the Commissioners pointed out that the scope of the Lunacy Acts is not thus limited. They said: 'The object of these Acts is not, as your Lordship is aware, so much to confine lunatics as to restore to a healthy state of mind such of them as are curable, and to afford comfort and protection to the rest. Moreover, the difficulty of ascertaining whether one who is

[1] 16 & 17 Vict. c. 96, s. 4.

[2] All the Lunacy Forms can be procured at Messrs. Shaw & Sons', Fetter Lane, Fleet Street, London, E.C.

insane be dangerous or not is exceedingly great, and in some cases can only be determined after minute observation for a considerable time.' 'It is of vital importance that no mistake or misconception should exist, and that every medical man who may be applied to for advice on the subject of lunacy, and every relative and friend of any lunatic, as well as every magistrate and parish officer (each of whom may be called upon to act in cases of this sort), should know and be well assured that, according to law, any person of unsound mind, whether he be pronounced dangerous or not, may legally and properly be placed in a county asylum, lunatic hospital, or licensed house, on the authority of the preliminary order and certificates prescribed by the Acts.

'Upon the whole, it appears that the power to restrain and confine a lunatic is limited at common law to cases in which it would be dangerous either as regards others or himself for the lunatic to be at large; but that the power to place and detain a lunatic in a registered hospital or licensed or other house, under an order and medical certificates duly made and obtained in accordance with the provisions of the Lunacy Acts, is not so limited.'

Duties of a Medical Officer to a Union with regard to Lunatics.

Every medical officer of a union district, on his becoming aware that any pauper resident in his district is, or is deemed to be, a lunatic and proper person to be sent to an asylum, must within three days give notice in writing to the relieving officer, or, failing him, to the overseers, subject to a penalty not exceeding £10 for neglect. A medical officer paid to visit a lunatic in his district, renders himself liable to fine, if, for the sake of retaining the fee, he does not send such lunatic to an asylum when necessary.[1]

[1] See Sabben & Browne's *Handbook of Law and Lunacy.*

TOXICOLOGY.

Toxicology is that division of forensic medicine which takes into consideration the modes, the actions, and also the methods of detecting poisons when occasion requires.

Poison.—Neither the law nor medicine defines a poison; but for all practical purposes a poison may be defined as *any substance which, introduced into the system or applied to the body, is injurious to health and destroys life, irrespective of temperature or mechanical means.*

The following is an attempt at classifying poisonous substances:—

Chemical.

Corrosive,	Acids.
	Alkalies.
	Caustic salts.
Vulnerant,	Glass, needles.

Vital.

Irritant,	Metalloid,	Phosphorus, iodine.
,,	Metallic,	Arsenic, antimony, etc.
,,	Vegetable,	Gamboge, colchicum.
,,	Animal,	Cantharides.
Narcotic,	Somniferous,	Opium.
,,	Delirant,	Hyoscyamus, belladonna.
,,	Inebriant,	Alcohol, chloroform, ether.
Sedative,	Cardiac,	Digitalis, etc.
,,	Cerebral,	Hydrocyanic acid.
,,	Neural,	Aconite, conium.
Excitomotory,		Strychnia, ergot.
Toxicæmic or septic,		Snake venom, etc.
Irrespirable gases,		Carbonic acid, etc.

Table showing the Mode of Action of Poisons, and the Causes which modify their Action.

MODE OF ACTION.

1. Local. 2. Remote.

1. *Local.*

a. Corrosion of the part to which the poison is applied.	Strong acid, alkali, etc.
b. Inflammation the result of irritants applied to a part.	Arsenic, cantharides, etc.
c. Effects on the nerves of motion and sensation.	Dilatation of the pupil from belladonna, and tingling of the tongue and skin from aconite.

2. *Remote.*

a. Common—not to be distinguished from the effects of injury or disease.
b. Specific—peculiar to the poison itself.

b. Specific.

1. General—affecting the whole system.—Antimony.
2. Partial—acting on a particular organ.—Antimony.

MODIFYING CAUSES.

a. Quantity.	1. Quantity of the poison increases its rapidly fatal action. 2. Action changed by the size of the dose. Thus, oxalic acid in large doses acts as a corrosive; in small, on the heart, brain, or spinal cord.
b. Form.	*Solubility* increases the activity of poisons. *Chemical combination.* Baryta is poisonous, sulphate of baryta is inert. *Mixture.* Dilution may retard or accelerate the action of a poison.[1]

[1] Dilution lessens the activity of some poisons, by prolonging the time necessary for their absorption; but in the case of powerful irritants, which act through the blood, moderate dilution increases their activity, by enabling them to enter the vessels more easily. Oxalic acid is an example of the effect of dilution as a modifying agent in its action. A small concentrated dose acts as an irritant; diluted, it is soon absorbed, and quickly causes death.

c. Point of application.	Skin, mucous membrane, serous membrane.
d. Condition of the body.	Habit — generally lessens the action of poisons. Idiosyncrasy—increases or may lessen the action of poisons. Disease — generally lessens the action of poisons.

GENERAL EVIDENCE OF POISONING.

It will now be necessary to consider briefly the general evidences of poisoning, in order to determine whether a death alleged to be due to poison is not really the result of disease. For convenience of description, this subject will be divided into five sections.

1. Evidence from the symptoms.
2. " " *post-mortem* appearances.
3. " " chemical analysis.
4. " " experiments on animals.
5. Moral evidence.

1. *Evidence from the Symptoms.*—As a general rule, except in cases of slow poisoning, the symptoms come on suddenly, while the person is in apparent health. In cases of homicide, this suddenness in the accession of the symptoms is particularly to be noticed. But it must also be borne in mind that the invasion of many diseases is sudden, as is the case with cholera, gastritis, and some others.

Certain conditions of the system more or less modify the effects of some poisons. Thus, sleep delays the action of arsenic; and this may also be the case with other poisons. Intoxication has also been said to exert a retarding power over the action of certain poisons. This is probably more apparent than real, the fact being that the symptoms in the cases observed are masked.

Much more important, however, is the influence

of disease. Large doses of opium are well borne in mania, delirium tremens, dysentery, and tetanus; whereas it is well known that even small doses of mercury in cases of Bright's disease of the kidney, or in children recovering from any of the eruptive fevers, have produced dangerous salivation.

The symptoms of poisoning go on from bad to worse in a steady course; but there may be remissions, followed, under treatment, by their entire disappearance, no ill effect remaining. In nervous affections, all the symptoms must be taken into consideration, and these will be found to differ from those of any known poison. The history of the case should also have due attention paid to it.

In poisoning, the symptoms appear soon after food or drink has been taken. This is open to the objection that apoplexy has occurred immediately after a meal. The probative value of the above statement is, however, increased if several persons have been similarly affected after partaking of the same dish, especially if the symptoms followed within a short time of the meal. But it must also be remembered that all persons are not affected alike by the same poison. A whole family may be attacked with symptoms which point strongly to the use of poison, and yet death be the result of disease.[1]

Again, the diagnostic value is weakened if it can be proved that the person or persons affected have taken nothing in the way of food for two or three hours previously. Poisons may be introduced into the system otherwise than by the mouth; that is, they may be placed in the vagina or rectum, or inhaled when volatile poisons are used. Sometimes a poison has been introduced into the medicine, or a poisonous draught substituted for the one prescribed. In any case, where suspicious symptoms suddenly occur, the poison has most probably been taken in from half an

[1] See Taylor on Poisons, second ed. p. 120.

hour to an hour previously, and it is of special importance to note the period of time that may have elapsed from the accession of the symptoms and the last meal.

2. *Evidence from Post-mortem Appearances.*—The morbid appearances found in cases of poisoning will be treated more in detail when each poison or group of poisons comes to be separately considered. A caution may be given here against allowing the *post-mortem* signs of disease or external injury to exclude the idea of poisoning; for death may to all appearance be the result of disease or injury, and yet caused by poison. An attention to the *post-mortem* appearances is important in all cases; for in many instances where the symptoms were unknown to the experts at the time the inspection was made, they were subsequently found to correspond with the morbid changes which the autopsy revealed.

3. *Evidence from Chemical Analysis.*—The detection of poison in the body is of course the most important proof of poisoning; but it may be suggested that the poison was introduced after death, which, to say the least, is a most ingenious line of defence, but which at the same time must be held to be highly improbable. Again, granting that poison has been taken, is it the cause of death? This question may arise when injuries are found on the body, and it then becomes a matter of importance to know something of the symptoms which preceded death, and the morbid appearances found after death. The poison may disappear from the body. This may be effected by vomiting and purging; or, becoming absorbed and decomposed, it may be discharged by the urine and other excretions. Some poisons, especially those which are sparingly soluble, are with difficulty removed from the stomach even by the most incessant and violent vomiting. This is notably the case with arsenic, which adheres to the mucous coat of the stomach with considerable

tenacity. But even after all traces of the poison have left the stomach, it may be detected in the solid viscera. With regard to arsenic, the following table, taken from Taylor, is of importance, as showing the amount of the poison which may be found in the liver at certain intervals:—

After taking the poison.	Total weight of arsenic.
In 5½ to 7 hours, ...	0·8 grains.
,, 8¾ ,, ...	1·2 ,,
,, 15 ,, ...	2·0 ,,
,, 17 to 20 ,, ...	1·3 ,,
,, 10½ days, ...	1·5 ,,
,, 14 ,, ...	0·17 ,,

Is it necessary that the poison should be found in the body or in the evacuations, to lead to a conviction for poisoning? On this point, Christison is of opinion that if the symptoms, *post-mortem* appearances, and moral evidence are very strong, it is not necessary that the poison be found in order to establish a charge of poisoning. Many of the vegetable poisons almost defy detection, except by the symptoms and *post-mortem* appearances. The detection of poison in the food taken, or in the vomited matters, is of great importance; but it is of still greater importance if it can be found in the urine, this being a proof that it has passed through the system. Here again a caution is necessary; for it must be remembered that poisoning may be *feigned* or *imputed*,—the poison being mixed with the food and evacuations, and an innocent person accused.

4. *Evidence from Experiments on Animals.*—The evidence derived from experiments on animals with the contents of the stomach and vomited matters must not be too implicitly trusted, as these may give rise to vomiting and other symptoms when no poison is present. All animals are not alike affected with man by the same poisons; and it appears that the dog and the cat are the only animals that at all

approach man with regard to the effects produced. Experiments on the lower animals are useless to decide—

a. The fatal dose of any poison.

b. The rate of absorption, deposition, or elimination of poisons.

c. The rapidity of the action of certain poisons.

In the case, however, of some vegetable poisons, the effects produced on animals by a portion of the substance taken by the person suspected of having been poisoned, may afford corroborative evidence of poisoning.

The flesh of animals poisoned by accident, or intentionally, may seriously affect those who eat it. As a case in point, may be mentioned the injurious effects produced in some persons who had partaken of the Canadian partridges imported to this country some years ago, and which had probably eaten of some poisonous berries during the severe winter of that year.

5. *Moral Evidence.*—The moral evidence of poisoning is generally left to the jury to decide; but the value of this kind of evidence, in many cases, can only be fully appreciated by a medical witness. But to render this part of the subject as complete as possible, a few remarks will not be out of place. The suspicious conduct of the prisoner before and after the event; the recent purchase of poison; the mode of administration; the object of the prisoner in getting rid of his supposed victim; and the fact of several persons being alike affected, should be carefully noted down. The anxiety evinced during the illness of the deceased, and the hurry in the funeral arrangements, as showing an over-anxiety to remove all traces of his guilt, are suspicious. The probability of suicide is weakened by the state of the mind and the nature of the dying declarations of the deceased.

Lastly, it remains to be considered—*What is the duty of a medical man who suspects the action of poison in a patient on whom he is in attendance?*

In the case of *Reg.* v. *Wooler*, Baron Martin, who tried the case, in his charge to the jury, stated that, in his opinion, the medical men in attendance ought, 'when the idea of poisoning struck them, to have communicated their suspicion to the husband, if they did not suspect him; and if they did suspect him, they ought to have gone before a magistrate.' Suppose they had acted as the learned judge suggested, and spoken to the husband, he would, in all probability, have desisted from his terrible design for a time, and a great criminal would have been let loose on society, and without punishment. Then, again, had they applied to the magistrates, the delay caused by the indecision of the magistrates how to act in so delicate a case would have allowed the criminal to remove all traces of his design, and the means of testing their suspicions would have been lost; and, along with this, would have been lost the professional character and fortunes of the authors of the investigation. 'There is a third course,' says Sir R. Christison, 'and in my opinion it is the fittest of all. When the medical attendant is satisfied of the fact of poisoning, he should communicate his conviction to the patient himself. His predicament, in every other way, is so embarrassing, that he ought not to be deterred by the chance of injury to his patient from making so dreadful a disclosure.'[1] See an account of the same course being adopted in the case of Mr. Blandy by his physician, Dr. Addington, reported in Howell's *State Trials*, vol. xviii.

[1] See also Sir R. Christison's paper on the Wooler case, *Edinburgh Medical Journal*, vol. i. 1856.

Summary of the general Evidence of Poisoning, placed in a Tabular Form.

POISON.	NATURAL CAUSES.
1. The symptoms come on suddenly, and rapidly progress.	1. Many diseases come on suddenly—cholera, gastritis—and run a rapid course to a fatal termination.
2. The symptoms begin while the person is in sound health.	2. Most acute diseases begin under like circumstances.
3. The symptoms of poisoning go on from bad to worse in a steady increase.	3. This is also the case with many common diseases.
4. Uniformity in the nature of the symptoms.	4. The uniformity of the symptoms is common to many diseases; but in some cases the absence of uniformity may be a proof of disease.
5. The symptoms come on immediately after a meal.	5. Apoplexy, colic, cholera, and some other diseases, may follow a meal. But the fact that some hours have elapsed since the last meal is against the probability of poisoning.
6. Several persons are attacked after partaking of the same meal with the same symptoms.	6. As a general principle, it may be stated that there is no disease likely to attack several persons at once, but cases are on record of this having occurred.
7. Poison found in the food, vomited matters, urine, etc.	7. Poison may be mixed with the food, etc., in cases of imputed poisoning.

Poison may not be found in the body, due to the following causes:—

a. Discharged by vomiting and purging.
b. The poison may have been absorbed.
c. The excess of the poison may have become decomposed.
d. Absence of the poison due to absorption and ultimate elimination by the kidneys, etc.

The following Table gives the names of the diseases whose together with such points of difference as may assist in

IRRITANT POISON.	CHOLERA.	ENGLISH CHOLERA.
Symptoms of violent irritation in one or more portions of the alimentary canal. Pricking and burning of the tongue and mouth, constriction of the throat, and intense thirst. Great abdominal pain and tenderness. Vomiting and purging are also usually present. The skin is hot and cold at intervals; the pulse small, frequent, and irregular. In the last stage the skin may become icy cold. *An acrid, metallic, or burning taste in the mouth precedes the vomiting.* The vomit is generally mixed with *blood.* Death occurs in from six hours to two days and a half.	Extreme and sudden prostration. The breath is cold to the hand in the last stages. The body is cold, shrivelled, and livid, or of a leaden hue. Vomiting and purging are present; the former is never bloody, the latter resembling rice water. The thirst is intense, and in this particular alone resembles the effects of irritant poison. Death in from one to two days, or even less.	In this disease all the symptoms of irritant poisoning are present. Pain in the belly, and vomiting. But in this disease the vomit is *never* bloody, most frequently bilious. *An acrid taste in the mouth and throat succeeds the vomiting.* This is due to the acrid nature of the vomited matters. The stools contain bile in English cholera, in irritant poisoning sometimes blood. Death is rare within three days.

symptoms resemble those the result of irritant poisons, distinguishing the one from the other:—

GASTRITIS.	ENTERITIS.	PERITONITIS.	PERFORATION OF THE STOMACH.
Acute gastritis is so rare in this country as scarcely to need description. Most of the cases recorded of acute gastritis have been found to be due to irritants.	Though more common than gastritis, enteritis is a rare disease. The bowels are generally *confined.* Tubercular and aphthous inflammation of the intestines may simulate irritant poisoning, especially chronic poisoning by arsenic. The *post - mortem* will reveal the true cause of death.	In the early stages of the disease vomiting is rare, and constipation is the rule. The morbid appearances in the peritoneum are seldom caused by irritants.	The symptoms supervene immediately after a meal; the pain, which is very acute, gradually extending over the abdomen. In most cases the patient suffers for some time previously from dyspepsia.

HERNIA.	INTUSSUSCEPTION OF THE BOWELS.	COLIC.	INTERNAL RUPTURE OF ORGANS.
Examine the seat of pain, the cause will be soon detected. But an omental hernia may be present, giving rise to twisting pain at umbilicus. *Post-mortem* will decide.	Pain, sudden and confined to one spot below the stomach. Vomiting is present *without* purging, thus differing from diarrhœa and cholera. After a time the vomit becomes fæcal.	May be confounded with poisoning by the salts of lead. If lead be taken in large doses, it produces the symptoms common to irritant poisons added to those of colic. In chronic lead poisoning, the blue line round the gums, the aspect of the patient, and history of the case, point to the true cause of the symptoms. Lead colic is also generally accompanied by extreme depression of spirits.	Rupture of the stomach, duodenum, gall bladder, and impregnated uterus is of rare occurrence. The autopsy will show the true cause of death.

The following Table gives the names of the diseases whose symptoms resemble those the result of narcotic poisoning, together with such points of difference as may assist in distinguishing the one from the other:—

NARCOTIC POISONING.	APOPLEXY.	EPILEPSY.
Giddiness, headache, drowsiness, and considerable difficulty in keeping awake. Paralysis of the muscles, convulsions ending in profound coma and death. The symptoms of narcotic poisoning begin not later than an hour, or at most two hours, after the poison is taken, except in the case of poisonous fungi and spurred rye, when a day or two may elapse. The symptoms of narcotic poisoning advance gradually. The person may, *in most* cases, be roused from the deepest lethargy. The pupil in opium-poisoning is almost always contracted. Recovery seldom occurs after twelve hours; in most cases death takes place in six or eight hours — the shortest time being three hours.	In some cases apoplexy is preceded by warning symptoms — headache and giddiness. As a rule, apoplexy is a disease of old age, and of stout, plethoric people. If the symptoms do not come on for some hours after food or drink has been taken, this disease is to be expected; but it may occur *at* or *immediately* after a meal, too soon to be the result of the action of narcotics,—10 to 30 minutes always elapsing before these poisons act. Apoplexy generally comes on suddenly, coma at once present. Seldom possible to rouse the person when the sopor of apoplexy is fully formed. The pupil in apoplexy is usually dilated. Apoplexy may last for days, or death may occur in an hour.	Loss of consciousness and presence of convulsions mark this disease; and in these it resembles poisoning by prussic acid. Epilepsy is in most cases a chronic disease. Warnings—aura epileptica — are often present. The fit begins violently and abruptly. The paroxysm generally lasts for some time, and death rarely occurs during the first attack.

Table showing points of difference in the action of corrosive and irritant poisons.

CORROSIVES.	IRRITANTS.
1. Destruction of the parts to which they are applied. No remote action on the system.	1. Irritation of the parts to which they are applied producing inflammation. Remote action present in most of the irritants.
2. Symptoms supervene immediately they are swallowed, and consist of a burning, scalding pain felt in the mouth, gullet, and stomach.	2. The symptoms may rapidly supervene after they are taken, or some delay may occur due to the state of concentration or dilution of the poison. Pain in the stomach and bowels more or less severe is always present with other signs of irritation.
3. Death may result from— *a.* Shock. *b.* Extensive destruction of the parts touched. *c.* Starvation. *d.* Suffocation the result of œdema, or spasm due to acid in larynx.	3. Death may result from— *a.* Shock. *b.* Irritation causing convulsions. *c.* Protracted suffering. *d.* Starved to death.
4. *Post-mortem* appearances: Corrosion and extensive destruction of tissue.	4. *Post-mortem* appearances: Irritation, and signs of inflammation, ulceration, etc.

CHEMICAL.

CORROSIVE.

The Mineral Acids.

General Characters.—The mineral acids have no remote effects on the system; their action is purely local. They are seldom used for the purpose of

homicide, except in the case of young children. By suicides they are more frequently employed.

The symptoms common to the action of these acids supervene *immediately* they are swallowed, and consist in a sensation of burning in the mouth and gullet. Dreadful pain is felt in the stomach, attended with constant eructations, and vomiting of a brownish or blackish matter mixed with blood. Mucus, together with, in severe cases, portions of the mucous membrane of the stomach, may be detected in the vomited matters, which have an intensely acid reaction, changing the colour and destroying the texture of cloth or other material on which they may fall. The act of swallowing is attended with intense pain, and not infrequently is rendered quite impossible. The thirst is intense; the bowels are confined; and the urine is diminished in quantity. The pulse is small and weak, and the skin clammy and cold. Respiration is performed with difficulty, and the countenance expresses the most intense anxiety. Sometimes, when the upper part of the wind-pipe is implicated, there is more or less cough, and difficulty of speech. The mouth is excoriated, the lips shrivelled and blistered. In children, when the acid has been poured far back into the mouth, by forcing the bottle backwards before emptying it of its contents, the mouth may more or less escape injury, and the signs of corrosive poisoning be absent. The teeth may become loose, and fall out of the mouth. The mental faculties remain clear, death generally coming on suddenly, the patient dying convulsed or suffocated. The period at which death ensues is very variable. Some cases recover, leaving the coats of the stomach more or less injured, and the general health greatly impaired.

Post-mortem Changes.—The body externally is healthy. The lips and external parts of the body, which have come in contact with the acid, are charred. The mucous membrane of the mouth,

shrivelled and eroded, is whitish, yellowish, or brownish, sometimes appearing 'as if it had been smeared with white paint.' Much of the appearance above described will depend upon the rapidity with which death has followed the swallowing of the poison. The mouth, gullet, and trachea may alone show any signs of the corrosive action, the acid never having reached the stomach. The stomach in some cases, more or less contracted and perforated by the corroding action of the acid, may contain a dark grumous liquid, the acidity of which will depend upon the treatment adopted, or the length of time that may have elapsed from the swallowing the acid to the fatal termination. The stomach also appears as if carbonized, this being due to the action of the acid on the effused blood; no such appearance being produced when sulphuric acid is poured into the dead stomach. The blood, Casper states, is never fluid in acute poisoning by sulphuric acid, but always 'syrupy at least, and sometimes ropy; it has a cherry-red colour, and *acid reaction*.'

There are two things which may render the diagnosis difficult:—

1. *Gastric Ulcer.*

2. *Post-mortem Digestion of the Stomach.*

Gastric ulcers vary in size from that of a fourpenny piece to that of a florin, or larger. In shape, they are round or oval, and present the appearance of shallow but level pits, with sharp, smooth vertical edges, appearing as if they had been punched out. The peritoneal opening is smaller than that on the internal surface of the stomach. The absence of injury to the mouth and gullet will distinguish *post-mortem* softening from the action of corrosive poisons. Sulphuric acid is said to possess powerful antiseptic properties, and that bodies of those who have died from its effects remain long fresh.

General Treatment.—Chalk, carbonate of magnesia,

the plaster from walls or ceiling of the apartment stirred in water, and followed by diluent drinks, barley water, linseed tea, etc. The use of the stomach pump is contra-indicated.

SULPHURIC ACID.

Forms.—Sulphuric acid occurs in two forms, *concentrated* and *diluted.*

Characters.—Concentrated sulphuric acid, as it is found in commerce, is a heavy, oily, colourless, or slightly brownish-coloured liquid, not fuming when exposed to the atmosphere; but when added to water, causing a rapid increase of temperature, which may crack the glass vessel in which the mixture is made. Sulphuric acid chars and destroys the texture of organic bodies placed in it. *Dilute sulphuric acid* is a colourless, strongly acid liquid, reddening litmus, and charring paper dipped into it when subsequently dried, care being taken not to scorch the paper.

Symptoms, etc.—The symptoms and *post-mortem* signs have been already described, p. 143 et seq.

Chemical Analysis and Tests.—The acid will have to be examined under the following heads:—

1. Simple, concentrated acid.
2. Dilute acid.
3. Mixed with organic liquids, food, vomit, etc.
4. On the clothes of the person injured.

1. *Concentrated Acid.*

a. Chars Organic Matter.—A piece of wood or paper placed in the strong acid rapidly becomes blackened.

b. Heat when added to Water.—Equal quantities of acid and water added together produce intense heat.

c. Evolution of Sulphurous Acid.—When boiled with chips of wood, copper cuttings, or mercury, fumes of sulphurous acid are evolved, detected by their sulphur-

like odour, and by their power of first bluing and then bleaching starched paper dipped in iodic acid.

2. *Dilute Acid.*

a. Chars Paper.—This only occurs when the paper is dried by the aid of heat, subsequently to moistening it in the dilute acid.

b. Precipitation of Sulphate of Barium.—A solution of nitrate and chloride of barium is precipitated by sulphuric acid in the form of a white insoluble powder, unaffected by nitric or hydrochloric acids, even when heat is applied. This test is so delicate, that a solution containing 1-25,000th by weight of the acid is precipitated by it.

c. Action of Heat.—The dilute acid is entirely volatilized by heat.

3. *Mixed with Organic Liquids.*

In tea, coffee, or beer, the mode of applying the tests are the same, the mixture being previously filtered. The following cautions are necessary :—

Objection a.—Alum, or any acid sulphate, would give all the reactions with the nitrate and chloride of barium.

Answer a.—Evaporate a portion of the doubtful liquid ; if pure acid, there will be no residue, sometimes only the *slightest trace* of sulphate of lead.

Objection b.—Erroneous estimation of free sulphuric acid, in consequence of the presence of some saline or neutral sulphates.

Answer b.—Evaporate as before. The free sulphuric acid separated by warming the liquid is then added to powdered carbonate of baryta until effervescence ceases. The resulting precipitate, when weighed, represents the free sulphuric acid present.

4. *Stains on Cloth.*

a. The strong acid changes the colour of black

woollen cloth to a dirty brown, the edges of the spots assuming a reddish tint after a few days. The dilute acid on the same cloth produces a red stain, which in time becomes brown.

b. The spots made by the strong acid remain damp for some time; strong sulphuric acid having a great affinity for water, continually absorbing moisture from the atmosphere.

c. The spot should be cut out, boiled in water, filtered and tested for free sulphuric acid.

d. A portion of the cloth not touched by the acid should be tested, in order to show that the sulphuric acid found is not due to sulphates present in the cloth.

e. An acid sulphate—bisulphate of potash—gives a reddish stain to black cloth like that produced by the dilute acid.

Test for this salt by incineration.

Fatal Period.—Average time before death ensues is from two to twenty-four hours. The shortest time was one hour, but in children death may be instantaneous. Life, however, may be prolonged for some weeks, or even months.

Fatal Dose.—One drachm in a healthy adult has proved fatal; on the other hand, however, four ounces have been swallowed without being fatal.

Treatment.—As before mentioned.

N.B.—This acid of late years has given rise to several actions, it having been employed to disfigure the person by throwing it in the face.

NITRIC ACID.

Forms.—Strong nitric acid, and dilute nitric acid.

Characters.—This acid is commonly known as *aqua fortis*, or red spirit of nitre. It is seldom used as a poison. The strong acid varies in colour from a pale yellow to a deep orange. The colour is due to ad-

mixture with peroxide of nitrogen. On *cloth* and *articles of dress* it produces *yellow stains*, which are darkened by the application of an alkali. If poured on copper cuttings, reddish fumes of nitrous acid are given off. The vapour of this acid has caused death. *Dilute nitric acid* is a colourless acid liquid not precipitated by nitrate of barium or nitrate of silver, showing absence of sulphuric and hydrochloric acids. All its alkaline salts are soluble in water.

Symptoms.—The symptoms have been before described, and are similar to those produced by sulphuric, though not quite so severe.

Chemical Analysis.—Nitric, like sulphuric acid, will be examined under four heads—

1. Strong, concentrated acid.
2. Dilute acid.
3. Mixed with organic liquids, food, etc.
4. On the clothes of the person injured.

1. *Concentrated Acid.*

a. Volatility.—When exposed to the atmosphere, strong nitric acid gives off colourless or orange-coloured acid fumes. Heated in a watch glass, it is evaporated without residue.

b. Action on Organic Matter.—The acid leaves on woollen clothes *a yellow-coloured stain*, which is darkened by the addition of an alkali. The colour of the stain is due to the formation of picric acid.

c. Action on Metals.—Gently heated in a test tube with copper filings, orange-coloured fumes are given off, which redden but do not bleach litmus paper. Starch paper treated with iodide of potassium becomes purple.

d. Solution of Gold.—If a small portion of gold leaf be put into the acid, no effect is produced; but on the addition of concentrated hydrochloric acid, the metal is rapidly dissolved.

2. *Dilute Acid.*

a. Absence of sulphuric and hydrochloric acids proved by no precipitate being formed with nitrate of barium and nitrate of silver.

b. If a piece of filtering paper be dipped into a solution of the acid saturated with carbonate of potash, it will burn like touch-paper.

c. The acid liquid saturated with carbonate of potash and evaporated, deposits fluted prisms.

d. A crystal so formed, moistened with distilled water on a plate, and then heated with strong sulphuric acid, and allowed to cool, gives with—

- *a.* A piece of *green sulphate of iron*—a dark green ring round the crystal.
- *b.* A small portion of *morphia*—a rich orange colour, a yellow liquid being formed.
- *c.* A small portion of *brucia*—a blood-red colour.

3. *In Organic Liquids.*

Due to the measures employed by way of treatment, the vomited matters may be neutral and yet nitric acid be present. The method adopted with viscid and turbid organic mixtures is to dilute them with pure water and then filter. If the filtrate be acid, it is neutralized with carbonate of potash, and evaporated. It is then set aside to crystallize, the crystals purified by digesting them in ether or alcohol. The crystals are again dissolved and re-crystallized. The tests just mentioned should then be employed. It should be remembered that nitric acid has a strong tendency to combine with solid organic structures, and to become decomposed. The parts of the body stained by the acid should therefore be digested in water at a gentle heat, the liquid cooled, filtered, and neutralized with carbonate of potash, and then examined for nitre.

4. *Stains on Clothes, etc.*

Macerate the piece of cloth in distilled water by the aid of heat. If the solution be acid, neutralize with carbonate of potash, and filter. Test the solution as before mentioned.

The action of a dilute solution of caustic potash on the following stains on cloth is characteristic :—

Nitric acid stain becomes of a clear orange tint.

Iodine stain disappears.

Bile stain remains unchanged.

Fatal Period.—Death may take place in an hour and a half, or life may be prolonged for some months.

Fatal Dose.—Two drachms.

Treatment.—As before mentioned when speaking of the acids generally.

HYDROCHLORIC ACID.

Syn. Muriatic Acid. Spirit of Salt.

Forms.—Strong and dilute acid.

Characters.—*Strong hydrochloric acid* is either colourless or has a bright yellow tint due to the presence of the perchloride of iron. It fumes in the air, and gives rise to dense white fumes when a glass rod moistened with ammonia is held over the surface of the acid.

The *dilute acid* is colourless.

Symptoms.—Poisoning with muriatic acid is so rare that the symptoms have not been well studied, but they do not appear to differ much from those produced by the action of the other acids.

Chemical Analysis.—The acid will have to be examined under the following heads :—

1. Simple, concentrated acid.
2. Dilute acid.
3. Mixed with organic liquids, food, etc.
4. On the clothes, etc.

1. *Concentrated Acid.*

a. Action on organic matter. The strong acid tinges most organic tissues, when immersed in it, a *yellow colour.* The stains on black cloth are at first distinctly *red,* becoming reddish brown after a few days.

b. Action on Metals.—This acid does not act on copper or mercury.

c. Hydrochloric acid added to peroxide of manganese, and then warmed, gives off chlorine gas, detected by its greenish-yellow colour and suffocating odour. The vapour thus produced bleaches litmus paper, and causes a blue coloration on starch paper moistened with iodide of potassium.

2. *Dilute Acid.*

a. Decomposes alkaline carbonates, chlorides being formed, which, when heated in the solid state with strong sulphuric acid and peroxide of manganese, evolve chlorine gàs, known by the before-mentioned tests.

b. Precipitation of Chloride of Silver. — A white curdled precipitate of chloride of silver is thrown down when a solution of nitrate of silver is added to hydrochloric acid. This precipitate becomes grey on exposure to light. If a portion of the precipitate be added to ammonia, it will dissolve; another portion is unaffected, even when boiled with nitric acid; and a third portion, ignited in a capsule, becomes converted into a horny mass.

In any case where there is a doubt as to whether the hydrochloric acid exists in the free state, or is only present in the fofm of chlorides, the following test should be resorted to, which will not only discriminate between the two forms, but give the relative amounts of each present :—

Take two equal measures of the acid liquid. Precipitate one with nitrate of silver, after the addition

of nitric acid, and weigh the precipitate. Evaporate the second portion of the acid liquid to dryness, and dry the residue in a water bath; dissolve this residue in distilled water, and treat the solution with nitrate of silver as before, weighing any precipitate which occurs. The weight of chloride of silver obtained from the first portion of the liquid will give all the hydrochloric acid present, both in the free state and in combination, while the weight of the silver precipitate in the second portion of liquid only gives the chlorides, all free hydrochloric acid having passed off during the process of evaporation.

Mixed with Organic Substances.—The suspected acid liquid should be filtered, and then distilled almost to dryness. The portion of the distillate which comes over at first, may be thrown away; but the latter portion will give all the reaction before described for hydrochloric acid, if that be present. Distillation is adopted in the case of this acid, as it is more volatile than either sulphuric or nitric acid. It may be objected that the acid found in the vomited matters is from the gastric juice. In answer, it may be stated that the free hydrochloric acid in normal gastric juice is only about five grains in sixteen ounces, an amount which would give but slight reaction with the tests.

On Clothes.—The spots produced by the action of the acid on black cloth are at first of a bright-red colour, changing in ten or twelve days to reddish-brown. These spots may be cut out and macerated in warm water; the liquid thus obtained tested by nitrate of silver and the other tests before noticed. Another portion of the cloth should be treated in the same manner, and the resulting liquid tested, as a set off against the objection that the acid was present in the cloth. Hydrochloric acid has been used to erase writing from paper, in attempts at forgery, etc. The paper must be treated in the same manner as men-

tioned for the cloth, and the tests used. Sometimes oxalic acid is employed for a like purpose, in which case the nitrate of silver will give a precipitate; but the oxalate of silver is soluble in nitric acid: the chloride is not soluble even when boiled.

Fatal Period.—From four or five hours to thirty hours or more.

Fatal Dose.—One ounce.

Treatment.—The same as for the other acids.

Table showing the colour produced by the action of the Mineral Acids on the Skin.

Nitric Acid.

Bright-yellow, due to the formation of picric acid. Colour heightened by alkalies.

Sulphuric Acid.

Brown colour.

Hydrochloric Acid.

White colour.

THE ALKALIES.

POTASH. SODA. AMMONIA.

Poisoning by the use of alkalies is very rare. For the sake of convenience, and as the symptoms produced by soda and potash, taken in large doses, do not greatly differ, one description will do for both:—

Potash is found in commerce, as—

1. Caustic potash, either solid or in solution.
2. Carbonate and bicarbonate.
3. Pearl-ash and soap-lees.

Soda is found as—

1. Caustic soda.
2. Carbonate and bicarbonate.
3. Soap-lees, carbonate of soda mixed with caustic alkali.

General Characters.—Like the inorganic acids, the alkalies destroy the animal tissues with which they come in contact. Their action is local, no specific remote effects being produced. They are seldom, if ever, used for the purpose of homicide; the deaths caused by them are in most cases the result of accident. When injected directly into the veins of animals, the action of potash and soda appears to differ, the former arresting the action of the heart, the latter arresting the circulation in the pulmonary capillaries—death ensuing in both cases.

Symptoms. — During the act of swallowing, the patient complains of a caustic taste, accompanied with a sensation of burning in the mouth and throat, extending into the stomach. Vomiting may or may not be present; but in severe cases, when it does occur, the vomited matters may be mixed with blood. The surface of the body is cold, and bathed in a cold sweat. Purging is generally present, accompanied with intense pain and straining. The pulse is weak and quick, and the countenance anxious.

The post-mortem appearances are inflammation and softening of the mucous membrane of the mouth, gullet, and stomach, which may also be covered with chocolate or black-coloured spots. Where life has been prolonged for some months the stomach may become contracted, the pyloric orifice scarcely admitting the passage of a fine probe.

Chemical Analysis.—The following table will show the reaction of these alkalies with reagents.

The carbonates effervesce on the addition of an acid.

To distinguish Caustic Potash from Caustic Soda.

	POTASH.	SODA.
Bichloride of Platinum.	Canary - coloured precipitate in solutions acidulated with hydrochloric acid.	No precipitate.
Strong solution of Tartaric Acid.	Precipitate in granular white crystals.	No precipitate.
Colour given to flame.	Rose or lilac tint.	Yellow tint.

In Organic Mixtures.—If the mixture be strongly alkaline, filter and test as before.

Fatal Period.—From three hours to as many years.

Fatal Dose.—About half an ounce of the caustic alkali.

Treatment. — Water freely. Drinks containing citric or acetic acid, vinegar, lemon juice, oil, linseed tea, and other demulcent drinks.

AMMONIA.

In vapour, in solution, or solid.

Symptoms.—The vapour may cause death by producing inflammation of the lârynx and lungs. The symptoms to which it gives rise are a feeling of choking, and a suspension of the power of breathing. Intense heat and pain are felt in the throat, which may remain for some time. When ammonia is swallowed in solution, the symptoms produced are not unlike those the result of the action of soda or potash, only more intense.

The post-mortem appearances are those found in most cases of poisoning by corrosives.

Chemical Analysis.—The vapour of ammonia is easily set free and recognised by its pungent odour. The carbonate effervesces when an acid is added to it, and gives a white precipitate with salts of lime.

Fatal Period.—Death has been known to occur in *four minutes*, but life may be prolonged for some time, the person dying of some thoracic trouble.

Fatal Dose.—A tea-spoonful of the strong solution.

Treatment.—Vinegar and water. The rest of the treatment will depend upon the symptoms present.

CAUSTIC SALTS.

Chloride of Antimony; Chloride of Zinc; Chloride of Tin; Nitrate of Silver.

CHLORIDE OF ANTIMONY.

Butter of Antimony.

Chloride of antimony is a corrosive liquid. The colour varies from a light yellow to a dark red. Though a powerful poison, it is seldom taken for that purpose. It has been taken by mistake for ginger beer. On the addition of water, the white oxychloride is precipitated.

Symptoms.—The symptoms produced by swallowing this substance are those of corrosive poisoning. The mouth and throat are excoriated, the skin cold and clammy, and the pulse feeble and quick. Severe pain is felt in the stomach, and vomiting is incessant.

Post-mortem Appearances.—Those found after corrosive poisoning.

Treatment.—Milk, magnesia, and infusions containing tannin.

CHLORIDE OF ZINC.

This substance is a powerful corrosive. It is employed as a disinfectant, and is sold to the public under the name of 'Sir W. Burnett's Fluid.' This preparation, which is a strong solution of the chloride of zinc, has caused death by being mistaken for 'fluid magnesia,' and in one case for pale ale. It is also used in the treatment of cancer and other tumours as an external application.

Symptoms.—The symptoms come on immediately after the poison is swallowed. It acts as a powerful corrosive, accompanied with all the symptoms which have been before described when speaking under the head of corrosive poisons. The nervous system is also powerfully affected.

Post-mortem Appearances.—Those of corrosive poisoning in its most violent form. The mouth, throat, stomach, and intestines are often found hardened, white, opaque, and corrugated.

TIN.

This metal requires but little notice; but the two chlorides—protochloride and the perchloride—form a mixture used in the arts, and known as *Dyer's Mixture.* They act as irritant poisons, but are seldom used as such.

SILVER.

The only preparation of silver requiring notice is the nitrate; *lunar caustic* or *lapis infernalis.*

It acts as a powerful corrosive. If administered for some time in small doses, it is deposited in the skin, which acquires a permanent dark colour. It does not appear to be eliminated by the urine, and has been discovered in the liver five months after its administration was discontinued.

The symptoms come on immediately; the vomited matters becoming blackened on exposure to light. The dark spots on the skin will also help to point to the nature of the poison. A dose of salt and water may be given by way of treatment.

VULNERANT.

Glass, Enamel, and Needles.

None of the above can be considered as poisons; but should they be taken, they in most cases give rise to irritation of the stomach and bowels. Pins and needles have been swallowed without doing much harm. Mixing ground glass in food is a favourite mode of killing adopted by the West Indian negroes.

VITAL.

IRRITANTS.

METALLOID.

Phosphorus. *Iodine.*

PHOSPHORUS.

Poisoning by this substance is more common in France than in England. In England, the deaths due to this poison are more frequently the result of accident from the incautious use of phosphorus paste for the destruction of vermin. Children have also been poisoned by sucking the heads of lucifer matches. It has most frequently been employed as a means of suicide, but seldom for the purpose of homicide. One case, however, occurred at the Bodmin Assizes in 1857. Kopf relates a case of a young woman, æt. 24, who died on the fourth day after swallowing the heads

of six packets of lucifers.[1] The size of the packets is not stated. In this case the bowels were confined, and the *post-mortem* revealed only the redness of inflammation in the stomach and bowels.

General Characters.—There are two kinds, ordinary waxy, crystalline phosphorus, and a peculiar form known as allotropic or amorphous phosphorus. As found in the shops, phosphorus is preserved in water in the form of translucent white or slightly yellow coloured cylinders. It is sparingly soluble in oil, alcohol, and other hydro-carbons, but greatly so in bisulphide of carbon. White vapours are given off when it is exposed to the air, these consisting of phosphorus and phosphoric acids.

Symptoms.—Phosphorus acts as an irritant poison, but some days may elapse after the poison is taken before the injurious effects become apparent. The patient may then complain of a garlic-like taste in the mouth, peculiar to poisoning by this substance. This is followed by a burning sensation in the throat, accompanied with severe pain in the stomach and intense thirst. The belly becomes swollen, and there is vomiting, in some cases of blood from the stomach, which may continue till death. The vomited matters are of a dark-green or black colour, with an odour of garlic, and sometimes appearing phosphorescent in the dark. This condition may also be observed in the motions passed. The pulse is feeble, the countenance anxious, and the surface of the body bathed in a cold sweat. In males priapism is not infrequent. The nervous and muscular debility is intense, and the patient may die in a state of collapse or during a fit of convulsions. The liver shares in the general disorder, and jaundice, more or less intense, not infrequently occurs.

Chronic poisoning, accompanied with all the symptoms just mentioned, may result from the action of

[1] *Allg. Wien. Med. Ztg.*, No. 47, 1849; Schmidt, vol. cv. p. 296.

the vapour on those engaged in the manufacture of phosphorus or of lucifer matches. In persons thus employed, necrosis of the jaws and caries of the teeth are not of infrequent occurrence.

Post-mortem Appearances.—Those of acute irritant poisoning, including extensive destruction of the coats of the stomach, by softening, ulceration, and perforation. The stomach may contain a quantity of white vapour, having a strong smell of garlic. This white vapour has been noticed to pass from the vagina and anus of those poisoned by phosphorus.[1] The blood appears to be thoroughly disorganized; the blood cells are colourless and transparent, their colouring matter being dissolved in the uncoagulated liquor sanguinis.

Chemical Analysis.—The smell of phosphorus is characteristic, as is also its luminosity when exposed in the dark. The following process, suggested by Mitscherlich, may be adopted for its detection :—

To render the suspected matter quite fluid, water is added, previously acidulated with sulphuric acid, in order to neutralize any ammonia present. The liquid is then transferred to a glass retort, fitted with a long condensing tube passing into a receiver. Distillation is conducted in the dark, when the minutest trace of phosphorus may be detected by the luminous appearance of the vapour during condensation. Other modifications of this process have been suggested in order to increase the space occupied by the phosphorescence.

By the above process, one part of phosphorus may be detected in 100,000 parts of substance. Another method for the detection of this poison in very minute quantities is that proposed by Dusart (*Compt. Rend.* xliii. 1126), and modified by Blondlot (*Compt. Rend.* lii. 1197). The test is based on the fact that when phosphorus is exposed to the action of *nascent hydrogen* in a Marsh's apparatus, it burns with an emerald-green flame. In order to avoid the yellow colouring

[1] See Casper, *Handbook For. Med.*, vol. ii. p. 100.

of the flame produced by the sodium in glass, Blondlot recommends the use of a platinum jet. As the green colour is more or less interfered with by the presence of organic matters, he passes the gas through a solution of nitrate of silver; the resulting precipitate is then placed in another hydrogen apparatus, as just mentioned, and the colour of the flame of the issuing gas noted. As phosphoric acid is taken in most articles of food, the only satisfactory evidence of phosphorus having been taken is to produce it in its free state, or at least to exhibit its luminosity. The detection of the colouring matter of lucifer matches in the stomach or vomited matters will point to the probable nature of the poison, and whence it is derived.

Fatal Period.—From four hours to twenty days or more.

Fatal Dose.—One grain and a half.

Treatment.—Emetics, use of the stomach pump, and the administration of demulcent drinks in which the hydrate of magnesia is suspended, will form the best mode of treatment. Oil should not be given, as phosphorus is soluble in it.

Synopsis of the Effects due to Poisoning by Phosphorus.

1. Which variety of phosphorus is poisonous?—The ordinary yellow phosphorus usually kept in water. The allotropic form is inert.

2. What quantity sufficient to kill an adult?—One grain and a half. Case quoted by Christison, *Poisons*, p. 188.

3. Symptoms as regards—

   a. *Alimentary Canal.*—Pain in the stomach and belly, eructations of gas smelling like garlic, vomiting, and sometimes purging, with other signs of irritation.

   b. *Circulatory System.*—Tendency to hæmorrhage from the mouth, stomach, lungs,

bladder, etc. If the case is prolonged, anæmia may be present. Pulse small, weak, and scarcely perceptible.

c. *Nervous System.*—Cramps, creeping sensations in the limbs, delirium, convulsions, paralysis, and extreme nervous prostration.

d. *Period of Invasions of the Symptoms.*—Obscure and insidious; some hours or even days may elapse before the appearance of the symptoms.

e. *Period of Fatal Termination.*—In some cases as short as four hours.

4. *Post-mortem* appearances.

a. *Alimentary Canal.*—Signs of irritation and inflammation in the stomach and intestines. Gangrene and perforation have been noticed. Strong smell of garlic when the abdomen is laid open. Appearances not unlike scurvy may be found.

b. *Cellular Tissue.*—Ecchymosis may be present in the cellular tissue of the abdomen, chest, and other parts of the body.

c. *Muscular Tissue.*—Fatty degeneration has been noticed in some cases.

d. *Liver.*—Fatty degeneration of the gland.

5. *Name* special affection produced by phosphorus in lucifer match makers.

Necrosis of the jaws, usually of the lower jaw. The disease in most cases begins in a decayed tooth.

6. *Name* a natural disease which phosphorus poisoning has been supposed to resemble.

Acute yellow atrophy of the liver.

IODINE.

Iodine is seldom used as a poison, owing to the

difficulty experienced in disguising its colour. In the form of a strong solution, it has been, however, employed for throwing on the person with intent to cause grievous bodily harm, as in this form it is corrosive, and destroys the parts which it touches.

General Characters.—Iodine is a dark grey solid, with a bright metallic lustre. It melts at 107°, boils at 175°, and gives off at the ordinary temperature a faint odour not unlike chlorine. But slightly soluble in pure water, it is readily dissolved when a soluble iodide is added to the water.

Symptoms.—Those produced by irritant poisons generally; the severity of the symptoms being increased by the strength of the solution, iodine possessing corrosive as well as irritant properties.

Post-mortem Appearances.—Those the result of acute irritant poisoning.

Fatal Period.—Two days.

Fatal Dose.—One drachm or less.

Treatment.—The stomach should be emptied by the aid of the stomach pump, and then diluent drinks—arrowroot and barley water—may be given.

Chemical Analysis.—Add bisulphide of carbon to the suspected mixture, and shake them together. The sulphide will dissolve out the iodine, which may be obtained on evaporation and sublimed. The characteristic reaction of iodine, the development of a blue colour on the addition of a small quantity of starch, will be conclusive evidence of its presence.

IODIDE OF POTASSIUM.

This salt is largely used in medicine; and though poisonous effects may be produced, due probably to some constitutional idiosyncrasy, it has been seldom used as a poison. It must, however, be placed among noxious irritant substances.

General Characters.—Iodide of potassium—hydrio-

date of potash—occurs in cubical crystals of a white or faint yellow colour, very slightly deliquescent when pure, and with a feeble odour of iodine.

Symptoms.—Iodide of potassium acts as an irritant in large doses, producing also many of the symptoms which attend a violent catarrh. Small doses—three to five grains—have produced in some persons most unpleasant and even alarming symptoms. In chronic poisoning, certain glands, the mammary and testicles, are said to waste away. Salivation is not infrequently present.

Treatment.—The use of emetics and the stomach pump, starch, etc.

Chemical Analysis.—In solution, iodide of potash gives the following characteristic reactions:—

a. With a salt of lead,	Bright yellow precipitate.
b. With corrosive sublimate,	Bright scarlet precipitate.
c. With strong nitric acid and starch,	A blue colour.

In organic mixtures the mode of detecting it is more complicated.

Sulphurated hydrogen should be first passed through the mixture in order to convert any free iodine into hydriodic acid. The excess of the gas is then driven off by the application of heat and potash added, the resulting liquid filtered, and the filtrate evaporated to dryness. To get rid of any organic matter, the residue left after evaporation is charred at a low red heat, reduced to powder, and dissolved in water. This solution is then concentrated, and strong nitric acid and solution of starch added, when, if iodine be present, the blue colour will be developed.

METALLIC IRRITANTS.

ARSENIC.

Arsenic is found as metallic arsenic, as arsenious acid, in the form of two sulphides—realgar and orpiment—and as a constituent of several ores—iron, copper, etc.

Metallic arsenic is of a steel grey colour, brittle, and sublimes at a temperature a little below 400° F., without, however, previously fusing. The vapour of the metal has a peculiar garlic-like odour, which is not possessed by any of its compounds.

Arsenious Acid.

Arsenious acid—white arsenic, the most important of all the compounds of arsenic—is colourless, odourless, and almost devoid of taste. As found in commerce, it occurs under two forms, as a white powder, and as a solid cake, which is at first nearly transparent, but soon becomes opaque, and then resembles white enamel. At a temperature of about 380° F. it sublimes, but is again deposited on cool surfaces in the form of octahedral crystals. It is but slightly soluble in cold water, only about half a grain to a grain being taken up by an ounce of water. Stirred in boiling water and then allowed to cool, from a grain to a grain and a quarter is dissolved in the same quantity of water; but when it is boiled for an hour, about twelve grains are dissolved in the ounce of water. This solubility is, however, diminished by the presence of any organic matter in the liquid. It is therefore less soluble in infusions of tea or coffee than in pure water.

Arsenious acid is used in the arts, in the manufacture of certain green colours, in dyeing, and in calico-printing. A weak solution is employed in medicine;

in the treatment of certain diseases of the skin, in ague, and in other diseases.

It has been proposed to use arsenious acid, on account of its caustic properties, as an application for cancerous tumours. The employment of this substance for this purpose is by no means new; but its use has been revived from time to time by the charlatan. In the year 1844, a man was tried at the Chester Winter Assizes—*Reg.* v. *Port*—for the murder of a woman whom he pretended to cure of a cancer by the use of an arsenical plaster. In another case, recorded by M. Flandin, where death occurred, the quack declared that he had not applied more than *four* or *five* grains to the woman's breast. The powder used by these gentlemen is generally composed of arsenious acid, realgar, and oxide of iron. The above cases, to which many more might be added, attest to the danger which attends the application of arsenic to the surface of the body; it should therefore never be used, especially as a more safe and potent caustic for this purpose is found in the chloride of zinc.

Farmers employ arsenious acid—white arsenic—for destroying vermin; for steeping corn in order to destroy any spores of fungi; and it also forms an ingredient in the wash for sheep. Injurious effects have followed the accidental use of the corn thus treated, and those employed in washing the sheep have suffered more or less severely.

By an Act of Parliament, 14 Vict. cap. xiii. sec. 3, it is ordered that if sold in small quantities, it must be mixed with soot or indigo, ten pounds being the smallest quantity allowed to be sold unadulterated.

The presence of this adulteration must be remembered, as a medical man may be led into an error when the vomited matters are coloured blue or black. Arsenic is not as a rule a corrosive poison, nor does it act chemically on the animal tissues. One case is, however, on record where it acted as a corrosive. Its

action is that of an irritant, causing inflammation in the stomach and bowels of those who have taken it; and it appears that these effects are produced whether the poison be swallowed or introduced into the system in any other way, *i.e.* by injection into the rectum or vagina, or applied to the surface of the body.

Arsenic cannot be considered in the light of an accumulative poison. Given in medicinal doses, it is eliminated in fifteen or twenty days. The kidneys speedily get rid of the poison from the body. Death may result from the application of arsenic to sores, or even if it is applied to a considerable surface of the body. It has also been injected into the vagina and into the rectum with an enema.

Symptoms of Arsenical Poisoning.

ACUTE.

The rapidity and virulence of the symptoms are more or less modified by the form (*i.e.* solution) and the quantity of the dose taken. From half an hour to an hour is the usual time which elapses before the symptoms of poisoning present themselves. In one case, when the poison was in solution, the symptoms came on immediately after it was swallowed; in another, after the lapse of eight months. The patient first complains of a feeling of faintness and depression, followed by intense burning pain in the stomach, increased by the slightest pressure. Nausea and vomiting, the latter increased by the act of swallowing, now occur. The vomited matters may be dark-brown, black, or bilious; or they may be greenish from the admixture of the indigo with the arsenic coming in contact with the yellow colouring matter of the bile. Blood may also be vomited. Purging,

CHRONIC.

The symptoms are not so well pronounced as in acute poisoning. The eyes become inflamed and watery. The skin may be irritable, and in some cases patches of a vesicular eruption — 'ekzema arsenicale'—appears. Arsenical poisoning has been mistaken for nettle rash and scarlet fever. Paralysis, more or less general, is not of infrequent occurrence. The sufferer emaciates, the hair falls off, and he dies from exhaustion. The tongue in some cases is excoriated, and salivation is also present, fœtor of the breath being well marked.

accompanied with straining at stool, and cramps in the calves of the legs may occur; the purging, like the vomiting, being incessant, and affording no relief to the sufferer. The thirst is intense, the pulse feeble and irregular, and the skin cold and clammy. As a rule, the symptoms in this form of poisoning are *continuous*; but cases occur in which there are distinct *remissions*, and even *intermissions*. Coma, paralysis, or tetanic convulsions, may supervene before death closes the scene.

Certain anomalies may occur.—The pain may be absent or but slight. Vomiting and purging do not occur in all cases, nor is thirst a most persistent symptom always present. In some cases the symptoms resemble those which accompany an attack of cholera. In others, signs of collapse first make their appearance, from which the patient may rally, or he may die outright. The severity of the symptoms does not appear to be affected by the *form* or *quantity* of the poison. It should also be remembered that arsenic may produce symptoms closely resembling those the result of *narcotic poisoning*.

Jaundice has also been noticed in some cases. The symptoms of this form of poisoning are frequently so misleading, that death due to the action of arsenic has been referred to 'spontaneous inflammation of the bowels.'

Post-mortem Appearances.—The appearances found after death depend upon the quantity of the dose and the length of time which supervenes between the taking of the poison and death. Inflammation of the stomach is a marked effect of the action of this substance on the system; and this condition is in most cases present whether the poison be swallowed, sprinkled on an ulcerated surface, or rubbed into the skin. When the poison has been swallowed, the stomach may be found covered with white patches of arsenic, embedded in dark-coloured thick mucus, mixed with blood. The inflammatory redness is some-

times found spreading over the entire surface of the stomach; at others, at the cardiac end only. The red colour is increased on exposure to the air. Perforation of the stomach is very rare. Inflammation of the stomach has been known to occur within *two* hours after swallowing the poison. Ulceration of the same organ has occurred in a person who died from the effects of arsenic in *five* hours (Christison *On Poisons*, p. 340).

The mouth, pharynx, and gullet are generally found free from any inflammatory action. The small intestines may or may not be affected; in most cases the duodenum alone shows any signs of irritation. The rectum is that part of the large intestine most prone to inflammation. The other internal organs—the liver, spleen, and kidneys—do not appear to be appreciably affected by arsenic.

Due, probably, to the antiseptic properties of arsenic, the stomach and intestines retain for a long time after death the appearances of irritant poisoning. In two cases this was so well marked as to be visible, in the one case after *twelve* months, and in the other *nineteen* months after interment.

The period which may elapse after Death when Arsenic may be Detected.

Arsenic is an indestructible poison, and may be found in the body after many years. In one case it was detected after the lapse of fourteen years. Arsenic has the power, to a certain extent, of arresting putrefactive changes; the stomach may therefore be found well preserved and with the signs of inflammatory action present after the lapse of many months, and after putrefaction had far advanced in other parts of the body.

The following table is taken from Taylor, and shows the amount of arsenic which may be found in the liver at the following periods:—

After taking the Poison.	Total Weight of Arsenic.
In 5½ to 7 hours, . . .	0·8 grains.
" 8¾ " . . .	1·2 "
" 15 " . . .	2·0 "
" 17 to 20 " . . .	1·3 "
" 10½ days, . . .	1·5 "
" 14 " . . .	0·17 "

In trials for arsenical poisoning, where an exhumation has been made, the question may arise whether the arsenic found in the body has been carried into it from the earth surrounding the coffin.

In reply, the following points must be kept in mind :—

a. Arsenic may occur in certain calcareous and ochrey soils.

b. In these soils no arsenical compound *soluble in water* has been found.

c. The arsenic of these soils is dissolved out by hydrochloric acid, proving their previous insolubility.

d. The arsenic is therefore probably in the form of an arsenite or arseniate of iron, lime, etc.

e. Careful experiments have rendered it evident that even 'under the most favourable circumstances the dead human body does not acquire an impregnation of arsenic from contact with arsenical earth' (Taylor).

f. It has been suggested that the arsenical compound in the soil may be rendered soluble by the ammonia formed during putrefaction. This suggestion is negatived by the following facts :—

- *a.* The production of ammonia ceases before the body arrives at that stage of decomposition when it is at all likely to be exposed to the action of the soil of the cemetery.
- *b.* The production of hydrosulphuret of ammonia during decomposition, would tend to the production of sulphuret of arsenic

forming yellow patches in the substance of the organs, thus rather fixing the arsenic in particular parts, than allowing it to percolate through the tissues of the body from external application.

Analysis of the suspected Earth.—About two pounds of the earth should be boiled for some time in water; the supernatant liquid should then be poured off from the insoluble residue, and filtered. The filtered liquid, after concentration, may then be examined by the tests about to be described. If no arsenic be found, the residue may be boiled with dilute hydrochloric acid, filtered, concentrated, and then tested as before.

Detection of Arsenic.

General Directions.—In cases of suspected poisoning by arsenic or antimony, the contents of the stomach should be mixed with distilled water acidulated with hydrochloric acid and filtered, the filtrate placed in a stoppered bottle, and lettered or numbered A or 1. The liver should be cut into pieces, some of which should be bruised in a mortar with distilled water acidulated as above mentioned, pressed and filtered, the filtrate placed in a bottle, and marked B or 2.

The kidneys and portions of the other solid organs may also be treated as before. Each solution so obtained may be then tested by the processes about to be described. By these means the amount of poison in each organ may be estimated.

Before subjecting the organic mixture to Marsh's or Reinsch's test, Brande and Taylor strongly recommend a modified course of procedure.

The liquid mixture, or the finely divided solid, is mixed with an excess of strong hydrochloric acid in a flask, and slowly distilled by means of a sand bath, the distillate carried into a receiver containing a little water, and the process continued nearly to dryness.

If arsenic be present, the distillate contains the arsenic as chloride, and can be at once subjected with great facility to the usual tests for the presence of that metal. This mode of proceeding both facilitates and expedites the ordinary methods of testing, as it separates the arsenic present from the complex organic mixtures with which it is associated, and presents it in a comparatively pure form for identification.

Marsh's Test.

This method for the detection of arsenic is founded on the fact that this metal forms a gaseous compound with nascent hydrogen, from which it may be readily separated by appropriate treatment.

The usual form of the apparatus is that of a U-shaped glass tube about one inch in diameter and eight inches high, supported in a vertical position on a wooden stand. One end of the tube is fitted with a tap, and terminates in a glass tube drawn to a fine point; the other end is closed with a cork. The apparatus is used as follows:—A piece of pure zinc is dropped into the tube, and shaken into such a position that it occupies the bottom of that limb of the tube which is furnished with a tap. Water is then added, and subsequently sufficient pure sulphuric acid to cause a moderately brisk evolution of hydrogen. The gas being allowed to accumulate for a short time, the tap is then partially turned on, and the gas ignited; if, on depressing a piece of white porcelain momentarily in the flame, no deposit or discoloration occurs, the reagents used may be taken as pure. The tap is now connected with a tube of thin hard glass drawn out to a fine point at the end, and having a constriction at the middle. The liquid to be tested being now placed in the apparatus, the gas is again ignited, and a piece of white porcelain momentarily depressed in the flame, when, if arsenic is present, a black metallic-looking stain will appear. Should this

prove to be the case, and while the gas is passing, the exit tube should be heated to redness a little before the constricted part, when a dark ring will appear. The black deposit on the porcelain may be either arsenic or antimony, but may be distinguished as follows :—

	ANTIMONY.	ARSENIC.
Heated with a little nitric acid,	Oxidizes to a white insoluble powder.	Dissolves.
Warmed with a strong solution of chloride of lime,	Is not dissolved.	Dissolves.
The nitric acid solution evaporated to dryness gives, with nitrate of silver,	No reaction.	A brick-red precipitate.

The portion of the tube on which the dark ring has been deposited is cut off, broken into fragments, and heated in a small, hard glass tube ; when, if arsenic be present, a white sublimate will be obtained of well-defined octahedral crystals. If the sublimate be treated with sulphide of ammonium, it will dissolve, and an evaporation of the solution to dryness—a residue of the yellow sulphide of arsenic—will remain, which, if heated with strong nitric acid, and evaporated again to dryness, will give a brick-red precipitate with nitrate of silver solution.

Reinsch's Test.

First obtain a clear solution by filtration or otherwise, and then proceed as follows :—Strongly acidify the liquid with hydrochloric acid, introduce some pieces of copper foil, and heat to near the boiling

point-of the liquid. Both the acid and metal must be previously tested to ensure their freedom from arsenic. Any arsenic present will then be deposited on the copper in the metallic state, either in the form of a black lustrous deposit, when the arsenic is present in any quantity, or else as a steel grey coating, when a minute quantity only is present. In either case, the copper foil, after remaining for some time in the suspected fluid, is taken out, introduced into the bottom of a hard glass tube, and heated to low redness, when the arsenic will sublime as arsenious acid in octahedral crystals, forming a ring in the cooler portion of the tube. The deposit is identified as arsenious acid by the form of the crystals, and by its deportment with the various reagents, as in the treatment of similar sublimates mentioned under 'Marsh's Test.'

Objections to Reinsch's Test.

The chief objection to Reinsch's Test is the possible impurity of the reagents used,—both these reagents, even when supplied as pure, being liable to contain traces of arsenic. As met with in commerce, both hydrochloric acid and metallic copper invariably contain minute quantities of arsenic, the former generally containing the larger quantity of that impurity. Although, by purchasing the purest possible reagents, especially prepared for analysis, it may be possible to ensure their freedom from arsenic; yet in all cases they should be tested before using them. Some of the hydrochloric acid should be diluted with distilled water, and gently heated with the copper foil. If no tarnishing or deposit of any kind occurs on the metal after a lapse of several hours, the reagents may be taken as pure, and the trial of the suspected substance at once made.

Bloxam's Method for the Detection of Arsenic.

Professor Bloxam has recently suggested an admir-

able and delicate process for the detection of small quantities of arsenic. The method is, like that of Marsh, founded on the property possessed by nascent hydrogen, of forming a gaseous compound with arsenic; but instead of the hydrogen being generated by the action of dilute sulphuric acid on zinc, Professor Bloxam generates the gas by an electric current.

The wires from the extremities of a battery terminate in small plates of platinum foil, which are plunged into the liquid to be tested, the apparatus being so arranged that the hydrogen gas evolved from the negative pole is alone collected. The issuing gas is tested in a similar manner to that obtained in Marsh's process. This method of Professor Bloxam's is exceedingly delicate, and possesses one great advantage, that no zinc being used, there is no danger of contamination by the use of impure metal; while, as nothing foreign is introduced during the process of testing, the liquid under examination is left pure for the application of other tests if necessary.

Fatal Dose.—Two grains in solution have been known to cause death. Recoveries have, however, occurred after an ounce or more of the poison has been taken. Vomiting and purging are more urgent when the dose is large, probably assisting to get rid of the arsenic before its fatal action is produced.

Fatal Period.—From twenty minutes to two or three weeks, and even later from the secondary effects of the poison.

Treatment.—Vomiting should be promoted, and diluent drinks largely given. The stomach pump, if it can be procured without much delay, should also be employed to empty the stomach. Symptoms as they occur must be treated on general principles.

The hydrated sesquioxide of iron, and the hydrated oxide of magnesia, and animal charcoal have been proposed and used as antidotes. The sesquioxide of iron can be prepared ready to hand by saturating the

tincture *feri sesquichloridi* with ammonia. It should be given freely. Reputed antidotes are useless when the poison is in the solid state.

Other Poisonous Compounds of Arsenic.

Arsenical Vapour.—The vapour from the flues of copper and arsenic smelting works in Cornwall escaping into the air may cause death to cattle, and the destruction of vegetation. The workmen in these works not infrequently suffer from eruptions on the skin, and from great constitutional derangement; but on the whole, taking into consideration the dangerous nature of their employment, the men appear to enjoy average health. Actions for damage and nuisance have resulted from the escape of this vapour from the factories.

Arsenite of Potash.—A solution of arsenite of potash, mixed with the tincture of red lavander. Better known as FOWLER'S SOLUTION, or as FOWLER'S MINERAL SOLUTION, or TASTELESS AGUE DROP. It is probably a solution of arsenious acid in carbonate of potash, and not a true arsenite of potash. This preparation is much used as a domestic remedy in ague in the Fens of Cambridgeshire. Death from its use is rare; but it is nevertheless too dangerous a medicine to be used recklessly. Idiosyncrasy has much to do with the action of the drug, some taking even large doses with impunity, whilst in others the smallest medicinal dose has produced alarming symptoms.

The mixture used for washing sheep, composed of tar water, soft soap, and arsenic, has caused death in twenty-four hours. The men engaged in dipping the sheep may suffer both locally and constitutionally from the effects of the arsenic in the solution.

Treatment.—As before described.

Analysis.—See p. 171 et seq.

Arsenite of Copper.—Scheele's, green, and the aceto-

arsenite of copper, Schweinfürt green, are met with in commerce and the arts as green pigments. Among workmen they are familiarly known as Emerald green, Brunswick green, or Vienna green. In France the term *vert Anglais*, or English green, has been given to them. Scheele's green contains about 55 per cent. of pure arsenious acid; the other, Schweinfürt green, about 58 per cent.

These colours are employed for various purposes, among which the following may be mentioned:—

a. Artificial flowers and other articles of dress.

b. Confectionery, pastry ornaments, and toys.

c. As green paint for the insides of houses.

d. In the green colour for wall papers.

e. In the green-coloured paper lining boxes, etc.

The employment of Emerald green in the colouring of wall papers is so extensive, that in the year 1860 an English paper-stainer stated that he used two tons of arsenic weekly. In 1862 the amount of this colour manufactured during the year was from 500 to 700 tons. As the colour is only loosely applied to the surface of the paper by means of a weak solution of size, it is easily brushed off, and may so impregnate the atmosphere of a room as to produce injurious effects on those who inhabit the apartment. In the case of ladies' dresses the following method is adopted: —'The colouring material is made by thoroughly stirring together a mixture containing, in definite proportions, the green pigment, cold water, and starch, gum-arabic, or some similar substance which shall give the colour consistence and adhesiveness. Not infrequently in this process the hand and forearm are freely used in the liquid to expedite the work. Of this mixture, properly prepared, the workman takes a quantity in his fingers and roughly spreads it over the muslin or fine calico. The fabric is then beaten and kneaded between the hands until it is uniformly coloured. The longer this process is continued, the

more perfect is the result. The cloth is now fastened to a frame for drying. In all this process of colouring, the hands, forearms, and frequently also the face of the operative, must become soiled with the green colour. It will be also observed that the colour is but loosely applied, *no mordant being used*, as in calico printing, to fix the pigment in the texture of the cloth.'

Symptoms.—All the effects produced by arsenic may result from the use of articles coloured with these pigments. Chronic inflammation of the stomach and bowels, and irritation of the eyes, accompanied in some cases with extreme nervous debility and prostration, are by no means uncommon in those employed in the manufacture of this 'cheerful,' but poisonous, colour. The skin of the hands, arms, and scalp are often attacked by a vesicular eruption or an erythematous redness. When it is borne in mind that, according to the analysis of Hofman, a single twig of twelve leaves may contain as much as ten grains of pure arsenic, it is not to be wondered at that the most serious results have occurred from the reckless use of these colours. In Prussia and France the use of the arsenical colours is prohibited.

Analysis.—Scheele's green is insoluble in water, but is soluble in ammonia, the solution having a blue colour, from the separation of the arsenious acid from the oxide of copper. A few drops of the blue ammoniacal solution poured on some crystals of nitrate of silver, the yellow arsenite of silver is formed. The tests before described are applicable for the detection of this substance.

ORPIMENT.

Orpiment, or yellow arsenic, one of the sulphurets of arsenic, has been used occasionally as a poison. It is also largely employed in the arts for paper-staining

and for colouring toys. In cases of arsenical poisoning, it is this compound that is commonly found adhering to the stomach and intestines. It is formed by the sulphuretted hydrogen, the result of decomposition, acting on the white arsenic swallowed.

REALGAR,

or red arsenic, is another of the sulphurets of arsenic, and, like orpiment, is largely used in the arts as a colour. It is also employed, like orpiment, as a depilatory, fatal results following its use for this purpose. The colour of this substance prohibits its frequent use as a poison.

Both of these compounds owe their poisonous properties to the amount of free arsenious acid which they contain, and which may be as much as 30 per cent.

Symptoms.—The symptoms produced by these substances are similar to those caused by arsenic. The fatal dose will depend on the amount of free arsenious acid which they each may contain.

Treatment.—Emetics, and demulcent drinks.

Analysis.—As before.

Metallic arsenic, fly powder, arsenic acid, and the arseniates of potash and soda, are all poisonous. The *papier moure* of the shops consists of blotting paper steeped in a solution of arsenite of potash. Macquer's neutral arsenical salt is the binarseniate of potash.

The symptoms which attend the internal administration of these substances are those of arsenical poisoning.

Treatment.—When metallic arsenic has been taken, vomiting must be promoted by the use of proper emetics. Tartar emetic should never be used. In the treatment for poisoning with arsenic acid, or of

the arseniates of potash and soda, the hydrated oxide of iron, or of the acetate of iron, should be used, as these substances are precipitated by the iron.

ARSENURETTED HYDROGEN

has proved fatal in several cases. It is generated in the process known as Marsh's test for arsenic, and is so poisonous that a very small quantity has caused death. In most cases death has been the result of accident.

Symptoms.—Giddiness, fainting, constant vomiting, pain in the stomach, and suppression of urine are among the most prominent symptoms.

The *post-mortem* appearances are inflammation of the stomach, with more or less softening of its coats. The liver and kidneys are also more or less affected, and have been found of a deep indigo colour.

Analysis.—This has been described when speaking of Marsh's test for arsenic.

ANTIMONY.

Antimony, the stibium of the ancients, is obtained from the native sulphide. Metallic antimony is of a bluish-white colour, crystalline, and brittle. It melts at about 840° F., and is slowly volatilized at a white heat.

Two compounds of antimony—tartar emetic and chloride of antimony—are alone of any toxicological interest.

TARTAR EMETIC.

Antimonium Tartaratum. Tartarated Antimony.

Tartar emetic occurs as a white powder, sometimes, however, with a yellowish tint. It may contain

minute portions of arsenic. It is soluble in about three parts of boiling water and fifteen of cold, and is insoluble in alcohol. The *vinum antimoniale* of the Pharmacopœia contains two grains of the salt in an ounce of wine.

Before 1856, poisoning by antimony was of rare occurrence, but since that year several cases of chronic poisoning have occurred, giving to this substance considerable importance.

Symptoms.—Tartar emetic is an irritant poison, but possesses slight corrosive properties. When taken in large doses, two or three drachms, it gives rise to a metallic taste in the mouth, which is not easily removed. In most cases violent vomiting follows immediately after the poison is swallowed, the vomiting continuing even after the stomach is emptied of its contents. Burning pain is felt at the pit of the stomach, accompanied with cramps in the belly and purging. There is considerable difficulty in swallowing, and the patient complains of tightness and constriction in the throat. The mouth and throat in some cases are excoriated, or covered with whitish aphthous-looking spots, which ultimately become brown or black. In some cases the thirst is intense, in others absent or nearly so. Cramps in the lower extremities, almost amounting in some cases to tetanic spasms, followed by extreme depression, are generally the precursor of a fatal termination. The urine is not suppressed, as is the case in arsenical poisoning. The skin is in some cases covered by a pustular eruption, not unlike that of small-pox. Such is an imperfect description of acute poisoning by antimony; it now remains to consider the symptoms which mark the chronic form of poisoning. These differ chiefly in being less intense and less rapid, the fatal termination being more prolonged. Chronic poisoning by small doses is that form of poisoning which appears most in vogue of late years. The un-

fortunate victim complains of constant nausea and retching. Food is objected to, as it only increases the vomiting. The matters vomited are at first merely mucus, but after a time they become mixed with bile. Each time the poison is repeated the symptoms become aggravated. Emaciation gradually sets in, and the person dies from complete exhaustion, or from the effects of a larger dose than usual.

Post-mortem Appearances.—The mucous membrane of the throat, gullet, and stomach is inflamed, and in some places softened and corroded. Aphthous-looking spots are not infrequently found on the mucous membrane of the stomach, and these may also be observed on the throat and on the small intestines.

The liver has been found in some cases of chronic poisoning, where the fatal termination has been for some time retarded, enlarged, and its structure so soft as to be easily broken down. The appearances above detailed may be more or less absent or present, according to the time that may have elapsed from the swallowing of the poison to the time at which death has occurred.

Elimination of Antimony from the System.—Antimony, taken in a large dose, or in small doses frequently repeated, appears to be rapidly absorbed and then eliminated from the system by the kidneys. Dating from the time at which the poison was swallowed, it will be found in the organs of the body in the following order:—

a. Stomach and bowels, but slightly in the liver.

b. Absent from the stomach, but present in the liver, spleen, and kidneys—traces in the blood.

c. Present in the fat and bones, with traces in the liver, fæces, and urine.

d. The period required for its complete elimination from the vital organs varies from fifteen to thirty days.

In other words, the presence of antimony in the

stomach and intestines points to the recent administration of the poison; and its absence from those organs, and presence in the others above mentioned, to a more remote period of administration.

It has been suggested that in some cases the poison may be eliminated by the mucous membrane of the stomach. This assumption is negatived by the fact that antimony has been found in the other organs of the body and *not* in the stomach.

Fatal Dose.—It is impossible to state with certainty the exact amount of antimony which may prove fatal, as recoveries have taken place even after an ounce had been taken. Large doses are uncertain in their effects, as the severe vomiting which they produce generally helps to get rid of the poison. In small doses, death may result from the depressing action which it exerts over the heart.

Fatal Period.—From a few hours to several weeks and even months.

Treatment.—Promote vomiting by the administration of warm water, or warm greasy water, and then give any vegetable infusion containing tannin, viz. tea, oak bark, or cinchona bark.

The Detection of Antimony.

Prepare the solutions of the liver and other solid organs, and also the contents of the stomach, as described under the detection of arsenic. Through a portion of one of the solutions pass a current of sulphuretted hydrogen, which will produce, if antimony be present, an orange-coloured precipitate of the sulphide of antimony. The precipitated sulphide is dissolved by hot hydrochloric acid with the evolution of sulphuretted hydrogen; and if the resulting solution be poured into water, a white precipitate is formed of oxychloride of antimony, soluble in tartaric acid. Marsh's and Reinsch's tests may also be used

for the detection of antimony. The former is, however, open to the objection, that antimony, when present in any quantity, rapidly precipitates on the zinc in the form of a flocculent black deposit, while the issuing gas is found to contain only traces of the metal.

Reinsch's test is, however, very delicate, and its application is in every respect similar to that in use for the detection of arsenic. The acid liquid should, however, be boiled down to a small bulk with the copper before a conclusion is drawn as to the entire absence of the metal.

[TABLE OF ARSENICAL DEPOSIT.

The following Table gives the characteristic reaction of the Antimonial and Arsenical Deposit.

	ANTIMONY.	ARSENIC.
The colour of the deposit on copper by Reinsch's test is	Violet hue.	Black and lustrous.
The coated copper heated in the end of a small tube.	No effect, or only a trifling white sublimate, non-crystalline, non-volatile.	Well marked sublimate of octahedral crystals, readily volatile.
The deposit on porcelain from Marsh's test,	Black, not lustrous.	Lustrous, of a hair-brown colour by transmitted light.
The deposit heated with hydrosulphuret of ammonium, and evaporated to dryness, and residue treated with ammonia,	Insoluble.	Dissolves.
The black deposit dissolved in strong nitric acid, evaporated to dryness, leaves	White insoluble powder.	Deliquescent residue.
Nitrate of silver gives, with this,	No reaction.	Brick-red precipitate.
The black deposit warmed with a strong solution of chloride of lime,	Not affected.	Dissolves.

It may be noted that mercury likewise yields a deposit on copper with Reinsch's test; but the coating is in this case either of a grey colour or white,

and silvery on the application of friction. When the coated copper is heated in a glass tube, there is a sublimate of metallic mercury readily aggregating into globules on being rubbed with a glass rod. If the deposit is trifling in quantity, a magnifying glass should be used to identify the metallic globules. This test at once distinguishes a deposit on copper due to mercury, from that produced under similar conditions by arsenic or antimony.

MERCURY.

Metallic mercury possesses no toxicological interest, as it appears to be almost inert, even in very large doses.

CORROSIVE SUBLIMATE

is the most important of the preparations of mercury. It either occurs in crystalline masses of prismatic crystals, or as a white powder. It is now known among chemists as the perchloride, though it is frequently spoken of as the bichloride, chloride, and oxymuriate of mercury. It has a powerful metallic and styptic taste, and is soluble in about sixteen parts of cold water and three of boiling water. Alcohol and ether readily dissolve it, *the latter having the power of abstracting it from its solution in water.* This property of ether is of importance as a means of separating corrosive sublimate from its solution in other liquids. It is important to remember that corrosive sublimate *is* soluble in alcohol. See *Reg.* v. *Walsh*, Kilkenny Summer Assizes, 1850. The Liquor Hydrargyri Perchloridi of the Pharmacopœia contains half a grain of the salt to a fluid ounce of water. Half a grain of the muriate of ammonia is added to increase the solubility of the mercurial salt.

Symptoms.

ACUTE.

The symptoms come on almost immediately the poison is swallowed. A strong metallic coppery taste in the mouth is experienced, and a choking sensation in the throat. Pain of a burning character is felt, extending from the mouth to the stomach. Nausea and vomiting of stringy mucus, more or less tinged with blood, accompanied with violent purging, the evacuations being also mixed with blood and mucus. The pulse is feeble, quick, and irregular; the countenance flushed or pale, and the tongue white and shrivelled. This appearance of the tongue is not present in all cases. The skin is cold and clammy, and the functions of the kidneys are arrested, there being in many cases complete suppression of urine. As is the case with other irritant poisons, the symptoms and effects produced admit of considerable variation. Thus there may be no pain in the stomach, and no purging. Salivation is present in some cases, but chiefly in those in whom the fatal termination is somewhat prolonged. This sign is not infrequently absent.

CHRONIC.

The symptoms present in this form of poisoning are modified by the size of the dose, and the interval allowed to elapse between each dose. Nausea, followed by occasional vomiting and pains in the stomach, are complained of by the patient. There is general constitutional disturbance, and consequent mental depression. Salivation, as might be expected, is a more prominent symptom than in acute poisoning; but it must be borne in mind that salivation may be intermittent, that is, it may cease and then reappear, even after the lapse of months, without an additional dose of mercury having been given in the interval. Salivation may also come on in the course of certain diseases, attacking the salivary glands, and it may also be produced by other causes — pregnancy, etc. The glands of the mouth become swollen and painful, the gums tender, and the teeth loosened fall out of the mouth. The breath has a peculiar offensive smell. The bowels are irritable, and diarrhœa is not infrequently present. It must be borne in mind that in certain diseases —granular disease of the kidney—the smallest dose of any mercurial preparation may produce profuse ptyalism. And the toxicologist must be careful not to mistake the affection known as *cancrum oris*, or 'the canker,' most common in delicate, ill-fed children and adults, for the effects of mercury. The nervous system is more or less affected, neuralgic pains and mercurial tremors being present in many cases. Paralysis may also occur, especially in those exposed to the vapour of mercury.

Post-mortem Appearances.—The morbid appearances are chiefly confined, as in the case with arsenic, to the stomach and bowels; but the corrosive action of the mercurial sublimate is more marked. Inflammation more or less intense is always present in the stomach, the mucous membrane of which may be found of a slate grey colour, corroded, and so soft as to scarcely admit of the removal of the organ without tearing it. The cæcum and rectum are also sometimes found inflamed, and the mucous membrane softened. Perforation of the stomach is very rare, only one case having been recorded in which this was present. The mouth, throat, and gullet may also present signs of the action of the poison similar to those just described as seen in the stomach.

Fatal Dose.—The smallest dose was *three grains* in the case of a child, but the exact amount to cause death in an adult has not been accurately determined.

Fatal Period.—From half an hour. No exact time can be stated.

Treatment.—Vomiting, if present, must be encouraged; if absent, it must be produced by emetics. Albumen, the white of egg, or vegetable glutin procured from flour by washing it in a muslin bag, should be given. The rapid removal of the poison from the stomach, however, is the end to which all our exertions must tend. The stomach pump should not be used if it can possibly be avoided, as it may greatly injure the softened mucous membrane of the gullet and stomach.

CALOMEL.

Calomel, or the subchloride of mercury, is not used as a poison. In large doses it may act as an irritant poison, and death has not infrequently occurred even from comparatively small doses. Profuse

salivation and gangrene of the mouth have resulted from its use, and cases are recorded of death resulting from these. In many cases idiosyncrasy appears to more or less modify the action of this preparation of mercury. The poisonous effect of calomel has been attributed to—

a. Adulteration with corrosive sublimate.

b. Conversion of the calomel into corrosive sublimate by the action of the hydrochloric acid of the gastric juice.

N.B.—The free acid of the gastric juice is in too small a quantity to materially alter the composition of the calomel.

AMMONIO-CHLORIDE OF MERCURY,

or white precipitate, may, if taken in large doses, produce alarming effects, but it cannot be regarded as an active poison. Its action is that of an irritant, accompanied with, in some cases, severe salivation.

RED PRECIPITATE,

or red oxide of mercury, possesses poisonous properties, but it is seldom employed as a poison. The symptoms most frequently present are vomiting, coldness of the surface of the body, stupor, pain in the abdomen, and cramps of the muscles of the lower extremities. The vomited matters are generally mixed with some of the red oxide.

CINNABAR. VERMILION.

A compound of sulphur and mercury in the form of a dark-red crystalline mass is known as cinnabar; and to the same substance reduced to a fine powder the name vermilion has been given. It is used as a red pigment. It can scarely be considered as a poison,

Orfila asserting that it is not poisonous. The vapour of this substance appears, however, to be capable of producing severe symptoms, and in one case profuse salivation resulted from the application of the vapour to the body.

CYANIDE OF MERCURY,

though an active poison little inferior to corrosive sublimate, is seldom used as a poison, probably from its being better known to chemists than to the general public. It differs from corrosive sublimate in having no local corrosive action. It has been supposed, but proof is wanting, that its injurious effects are due to its decomposition by the acids of the stomach and the formation of prussic acid. Death has occurred in nine days from a dose of ten grains. It acts as an irritant.

TURBITH MINERAL.

A powerful irritant poison, but seldom used. A drachm has caused death in a boy sixteen years of age. Coldness of the surface, burning pain in the stomach and bowels, with other symptoms of irritant poisoning, were present. After death the mucous membrane of the throat, stomach, and bowels were found considerably inflamed.

NITRATES OF MERCURY.

These substances—the nitrate and sub-nitrate—are used in the arts for various purposes. They act as powerful irritant poisons, with symptoms and *post-mortem* appearances not unlike those before described when speaking of the action of other irritants.

Detection of Mercury in the Tissues and in the Contents of the Stomach.

Mercury is particularly liable to be absorbed by the tissues; it also readily combines with various organic substances, gelatine, etc.

A. If the contents of the stomach are under examination, they should be filtered, the residue pressed and reserved for further examination.

The liquid may be concentrated, and while still warm slightly acidified with hydrochloric acid, and a slip of zinc foil, round which has been twisted a piece of gold foil, be introduced. If mercury is present, the gold will, sooner or later, lose its yellow colour, and its surface become white and silvery, while the zinc is wholly or partially dissolved. The gold being removed, separated from the zinc, washed, first with water and then with ether, is divided into two equal parts. One half may be heated in a reduction tube, when it will yield a sublimate of metallic mercury, identified by the spherical form of the globules under a magnifying glass, and their metallic reflection and complete opacity. The other half of the gold may be treated with nitric acid and heated, which will dissolve off the mercury. The resulting solution, after expelling the excess of acid by evaporation, will give a scarlet precipitate with iodide of potassium soluble in excess, and with protochloride of tin, a black precipitate of metallic mercury.

B. For the detection of mercury in the insoluble form, the residue from *A.* is dried; or if the tissues are under examination, they should be finely divided, and freed from superfluous moisture. In either case the substance is boiled in moderately strong nitric or hydrochloric acid (about one part of acid to four of water). After digestion for some time the liquid may be filtered, concentrated, and tested as in *A.* When there is reason to infer the presence of corrosive

sublimate in considerable quantity in an organic liquid, advantage may be taken of the solubility of the salt in ether, and the power possessed by this liquid of abstracting it from its aqueous solutions. The liquid is agitated with an equal volume of ether, the ethereal solution poured off and allowed to spontaneously evaporate, when the corrosive sublimate will be left in white silky prisms, yielding all the characteristic reactions of the salt.

Table showing the reactions of Corrosive Sublimate with Reagents.

1. With solution of iodide of potassium,	1. Bright scarlet colour.
2. With potash solution,	2. Bright yellow colour.
3. With hydrosulphuret of ammonia,	3. First a yellowish and then a black colour is produced.
4. Heated in a reduction tube,	4. It melts, boils, is volatilized, and forms a white crystalline sublimate.
5. With ether,	5. It is freely soluble in ether, and the ethereal solution, when allowed to evaporate spontaneously, deposits the salt in white prismatic crystals.
6. Heated with carbonate of soda in a reduction tube,	6. Globules of metallic mercury are produced.

LEAD.

Metallic lead is not poisonous; but it appears probable that when it is acted upon by the acids of the intestinal secretions, it may become so changed as to produce unpleasant symptoms. Any salt of lead is poisonous when in a condition to be absorbed into the system.

Sugar of lead and white lead are alone important, and will therefore be briefly considered.

SUGAR OF LEAD.

Acetate of Lead. Subacetate. Goulard's Extract.

General Character.—The acetate of lead, better known as sugar of lead, is not unlike loaf-sugar in its general appearance. It is usually met with in the form of solid crystalline masses of a white or brownish-white colour. To the taste it is sweet, a metallic astringent taste being left in the mouth. Acetate of lead is soluble in water and in alcohol. The subacetate is a more active poison than the neutral acetate. Sugar of lead is popularly considered as an active poison, but this does not appear to be the case. Sir R. Christison has given eighteen grains daily in divided doses for eight or ten days with no other unpleasant symptoms than slight colicky pains in the abdomen. Lead is probably eliminated from the system by the urine, and also by the milk; but there is reason to believe that when once deposited in the body, some considerable time is required for its complete elimination. Dr. Wilson is of opinion that in chronic lead poisoning the lead is more largely deposited in the spleen than in any other organ of the body. This organ should therefore always be carefully examined in suspected cases of poisoning by this metal.

GOULARD'S EXTRACT is a solution of the subacetate of lead. It may be of a reddish colour from the employment of common vinegar in the place of pure acetic acid in the manufacture. Goulard's lotion is the extract diluted with water.

WHITE LEAD—*Carbonate of Lead*, *Ceruse* or *Kremser White*—is used as a pigment. It is generally in the form of white, heavy, chalky masses, insoluble in water, and, when taken in large doses, poisonous. It is this substance which in the majority of cases causes chronic lead poisoning, or *painter's colic.*

The *chloride* and *nitrate*, the oxides, *litharge* and

red lead, are all poisonous; but the *sulphate*, due probably to its insolubility, appears to be inert.

Lead poisoning may result from—

a. Constant contact with lead and its salts in manufactories.

b. Its use in the arts and as a pigment. The injurious effects of this substance are strikingly seen among painters, the makers of glazed cards, and the workmen engaged in preparing Brussels lace—this material being whitened by beating white lead into the fibre. All thus employed are liable to suffer more or less from chronic poisoning.

c. Its application to the surface of the body in the form of ointment, plasters, cosmetics, and hair-dyes.

d. Drinking water impregnated with lead, from being stored in leaden cisterns or conveyed in leaden pipes.

'The action of water upon lead is much modified by the presence of saline substances. It is increased by chlorides and nitrates, and diminished by carbonates, sulphates, and phosphates, and especially by carbonate of lime, which, held in solution by excess of carbonic acid, is a frequent ingredient of spring and river water. But water highly charged with carbonic acid may become dangerously impregnated with lead, in the absence of any protecting salt, in consequence of its solvent power over carbonate of lead. In general, water which is not discoloured by sulphuretted hydrogen may be considered as free from lead; but there are few waters which have passed through leaden pipes, or have been retained in leaden cisterns, in which a minute analysis will not detect a trace of the metal; and were it not for the great convenience of lead, iron pipes and slate cisterns would, in a sanitary point of view, be in all cases preferable.

'Another cause of contamination by lead may arise from electric action, as where iron, copper, or tin is in

contact with or soldered into lead; and in these cases, owing to the action of alkaline bases as well as of acids upon the lead, danger may occur when it is thrown into an electro-negative as well as an electro-positive state.

'Cisterns are sometimes corroded, and their bottoms are perforated by pieces of mortar having dropped into them, the lime of which has caused the oxidation of the metal, and a solution of the oxide.' (*Brande and Taylor's Chemistry.*)

e. Lead may also find its way into the system by means of the food.

The use of leaden vessels in the manufacture of cider is attended with danger, and also the keeping of pickles in glazed earthenware jars. Rum has been known to have been dangerously impregnated with lead, leaden worms having been used attached to the stills. Many tobacconists are in the habit of using lead foil to wrap up their tobacco and snuff; this practice has resulted in several cases of chronic lead poisoning.

Symptoms.

ACUTE.	CHRONIC.
A metallic taste in the mouth, accompanied with dryness in the throat and intense thirst, is experienced by the patient soon after the poison is swallowed. In some cases, however, *two* or *more hours* may elapse before the effects of the poison begin to show themselves. Vomiting may or may not be present. Twisting colicky pains are felt in the abdomen, relieved by pressure in some cases. The paroxysms of pain may be separated by intervals of ease.	This form of poisoning generally occurs among painters, manufacturers of white lead, pewterers, and others. The early symptoms are those of ordinary colic, only more severe. The patient generally complains, in the first instance, of feeling unwell, and of general debility. He then suffers from pain of a twisting, grinding nature, felt in the region of the navel. The bowels are obstinately confined. The appetite becomes capricious, and may be

The bowels are, as a rule, obstinately confined, and the fæces are of a dark colour, from the formation of the sulphuret of lead. The skin is cold, the pulse quick and weak, and there is considerable prostration of strength. In some cases the patient suffers from cramps of the calves of the legs, and sometimes, in protracted cases, paralysis of one or more of the extremities may supervene. The effect on the nervous system is marked by giddiness and stupor, terminating in coma, or convulsions and death.

entirely lost. The mouth is parched, the breath fœtid, the countenance sallow, the skin dry, and general emaciation sets in. A nasty sweetish metallic taste in the mouth is present in most cases. Not infrequently the subjects of lead poisoning experience a peculiar form of paralysis of the upper extremities, well known as 'dropped hand.' It appears that this condition is the result of paralysis of the extensor muscles of the wrist. The muscles undergo a form of fatty degeneration. The lead appears to act primarily on the muscles, then on the nerves, and lastly on the nerve centres. One other symptom of importance has yet to be noticed. The gums, at their margins where they join the teeth, present a *well marked blue line.* This is not present in all cases, but it should be looked for.

N.B.—The symptoms produced by white lead—carbonate of lead—are those of *colica pictonum*, or *painter's colic*, described under the head of chronic lead poisoning.

Post-mortem Appearances.—In acute poisoning the mucous membrane of the stomach and intestines is inflamed, and is in some cases covered by layers of white or whitish-yellow mucus, more or less impregnated with the salt of lead swallowed. Corrosion of the mucous membrane may occur if the dose is large, and this condition is more frequently present when the neutral salt is taken.

In chronic poisoning there are no constant *post-mortem* appearances. The muscles of the paralysed

extremity are usually found flaccid, of a cream colour, and the subject of fatty degeneration.

Fatal Dose.—Sugar of lead is not an active poison, recovery having taken place after one ounce had been swallowed.

Fatal Period.—Uncertain.

Treatment.—The free administration of the sulphates of soda and magnesia. The carbonates should not be given, the carbonate of lead being poisonous. Vomiting should be promoted, and a powerful cathartic administered. Albumen and milk should also be given, as these precipitate the oxide. In the chronic form of poisoning, the iodide of potash and aperients, notably the sulphate of magnesia, should be administered. Sulphur baths are also useful in removing the lead from the system. By way of *prophylaxis*, it has been recommended that all those engaged in lead manufactories, or who are obliged to handle this metal frequently, should partake largely of lemonade made with sulphuric acid.

Detection of Lead in Organic Mixtures.

The contents of the stomach or vomited matters must be diluted with water and filtered. The residue left on the filter, washed with distilled water, should be set aside for further examination; the filtrate and washings acidified with nitric acid. A current of sulphuretted hydrogen passed through the solution will then throw down the whole of the lead, should any of that metal be present, in the form of a brown-black sulphide, which may be collected on a small filter and dried. The sulphide, boiled with dilute nitric acid, is partially converted into insoluble sulphate, and in part dissolved as nitrate. The carefully neutralized solution may be either tested at once or previously concentrated. In either case the production of a bright yellow precipitate, with a solution of bichromate of potash, and a similar one

with a solution of iodide of potassium, may be taken as conclusive of the presence of lead. The portion of lead deposited as sulphate will be found to be soluble in a solution of pure potash, the resulting liquid giving a brown-black precipitate on the addition of sulphide of ammonium.

The insoluble residue left on the filter should be incinerated in a porcelain crucible, either with or without nitric acid, care being taken not to raise the temperature more than is necessary to produce the desired effect; the carbonized mass boiled with dilute nitric acid and then filtered, the filtrate tested as before mentioned. It is often useful, as a preliminary test for the presence of lead in a soluble form, to dip a piece of bibulous paper into the clear liquid obtained by submitting the contents of the stomach or vomited matters to filtration, and then exposing the paper to the action of a current of sulphuretted hydrogen. If lead be present, blackening of the paper will take place.

COPPER.

Metallic copper, like metallic lead, is not poisonous, but its oxides are; it should, therefore, not be swallowed, as it is rapidly acted on by the intestinal secretions and poisonous compounds formed. An alloy of copper is used for ornamenting gingerbread, etc. All the salts of copper are poisonous. The most important are, however, the *sulphate, blue stone* or *blue vitriol,* and the *subacetate* or *verdigris.*

Copper is eliminated to a slight extent by the urine. It has been found in the stomach, liver, and intestines eight months after its administration had been discontinued. It has also been detected more readily in the bronchial secretion than in the urine.

Symptoms.

ACUTE.	CHRONIC.
The primary action of the sulphate of copper is that of a powerful irritant; but when absorbed, it appears to act chiefly on the brain and nervous system. Its irritant action is marked by nausea, vomiting, griping pain in the belly, which is greatly distended, and increased flow of saliva. The vomited matters are of a bluish or greenish colour, and the discharges from the bowels greenish and containing blood. The above-mentioned symptoms usually follow immediately after the poison is swallowed, and rapidly increase in severity. After a time the remote effects supervene, marked by headache, giddiness, laboured breathing, quick irregular pulse, coma or convulsions, paralysis, and death. The subacetate of copper or verdigris produces symptoms not unlike those just described. Jaundice and suppression of urine may result when either is taken. A *purple* line along the margins of the gums is present in some cases.	Constant and troublesome irritation of the stomach and bowels; vomiting and purging, attended with considerable straining at stool; loss of appetite, loss of power, and general emaciation sets in. The patient is subject to frequent trembling of the limbs, which may end in paralysis. The mouth is unpleasant, and a coppery metallic taste is experienced. Cramps or colicky pains in the belly are not infrequently present. Jaundice is sometimes present. The vomited matters are greenish; but the practitioner must not be led away, and thus mistake the colour of the vomited matters, which occur in some morbid states of the bile, for that the result of poisoning by a salt of copper. A form of chronic poisoning affecting workers in this metal, has been described by some French pathologists as 'copper-colic.' A cachectic condition of the system, accompanied with one or more of the symptoms already detailed, mark this form of poisoning.

Copper poisoning may result from—

a. Introduction into the system by using for culinary purposes copper vessels not properly tinned.

b. By constant application of the metal to the surface of the body, necessitated by certain processes in

its manufacture, and in its applieation for industrial purposes.

c. The use of certain preparations of this metal as pigment.

d. The use of German silver—an alloy of copper, zinc, and nickel—may be rendered dangerous by the action of acid food upon thé compound.

Post-mortem Appearances.—The mucous membrane of the stomach is inflamed, the inflammation extending sometimes into the gullet. The intestines are sometimes found perforated. The lining membrane of the whole alimentary canal presents a deep green colour, distinguished from that the result of a morbid condition of the bile by being turned blue on the addition of ammonia.

Fatal Dose.—Nothing certain is known as to the exact quantity that may prove fatal. It appears to be more dangerous in small doses than in a large one.

Fatal Period.—The shortest time on record is four hours.

Treatment.—As the salts of copper generally induce vomiting, it will only be necessary to assist their emetic action by the free use of warm water, milk, or any demulcent drink. As an antidote, large quantities of albumen and iron filings have been given, of which the former appear to be most efficacious.

Detection of Copper in Organic Liquids.

A. The finely divided tissue, or the contents of the stomach, are thrown on a filter, and the insoluble portion set aside for further treatment (B).

The filtrate and washings may now be concentrated, acidified with sulphuric acid, and a polished needle inserted in the liquid; and should no immediate deposition of metallic copper occur, it may be allowed to remain for several hours. The colour of the metallic deposit is highly characteristic of copper. As a corroborative proof, the concentrated liquid

may be placed in a platinum capsule with some fragments of zinc, when the copper will be deposited on the platinum capsule at the parts in contact with the zinc. The liquid may now be poured off, and the excess of zinc adhering to the platinum removed by dilute hydrochloric acid. The copper may now be dissolved off the platinum by nitric acid, the excess of acid driven off by heat, and the solution subjected to the following reagents:—

Ammonia precipitates a blue hydrate of copper dissolved in excess of the reagent, and forming a blue solution.

Sulphuretted hydrogen gives a deep chocolate-brown precipitate, even in acid solutions.

Ferrocyanide of potassium, a rich red-brown precipitate.

B. The insoluble portion from A is incinerated in a porcelain crucible. The ash thus obtained is digested in hydrochloric acid with the aid of heat, and evaporated nearly to dryness. The residue, dissolved in water, may be tested as under (A).

ZINC.

The sulphate and the chloride are alone important.

Sulphate of Zinc.—White vitriol or white copperas.

Symptoms.—The sulphate of zinc acts as a pure irritant. Violent vomiting, accompanied with pain in the abdomen, and purging, are the symptoms which first make their appearance. These may be followed by symptoms which betoken collapse, viz. coldness of the limbs, paleness of the face, irregular pulse, and fainting.

Post-mortem Appearances.—Presence of inflammatory action.

Fatal Dose.—Uncertain.

Fatal Period.—Death has occurred in four hours.

Treatment.—Tea, coffee, milk, warm water, albumen, and in some cases enemata of gruel and other emollients.

IRON.

The preparations of iron which are of importance, are the sulphate and the muriate.

Sulphate of Iron—Copperas or *Green Vitriol*—has been administered as a poison, but more frequently to procure abortion. An ounce has been taken with no other unpleasant effect than the production of violent pain, purging and vomiting. Constant application of this substance to the body has produced vomiting, pains in the belly and limbs. These symptoms disappeared on treatment.

Chemical Analysis—

1. *Hydrosulphuret of ammonia* gives a black precipitate.
2. Ferrocyanide of potassium added to it, in solution gives rise to a greenish-blue precipitate, becoming dark blue on exposure.
3. Chloride of barium will point to the nature of the acid present.

Muriate of Iron, better known as the *Tincture of Sesquichloride of Iron.*—The tincture acts as a corrosive and irritant poison, death having followed in five weeks after an ounce and a half had been swallowed. Recovery has, however, taken place after three ounces had been swallowed. The symptoms present in most cases observed, were those of a corrosive and irritant.

Chemical Analysis—

1. The addition of nitrate of silver, causing a white precipitate insoluble in nitric acid, points to the presence of chlorine.
2. The peroxide of iron indicated by the formation of Prussian blue on adding a solution of the *ferrocyanide of potassium.*

BISMUTH.

The preparations of this metal act as irritant poisons, death having occurred from a dose of two drachms of the subnitrate. Dr. Trail (*Outlines of Medical Jurisprudence*, p. 116) mentions the case of a patient of his who took *six drachms* in three days in divided doses. The symptoms were vomiting, extreme pain in the abdomen and throat, a weak, feeble pulse, and much anxiety about the præcordia. Recovery took place.

CHROMIUM.

Two compounds of this metal are largely used in the arts for dyeing purposes—the neutral chromate and the bichromate. The chromate of potash is a powerful poison, and death may occur from its direct action on the nervous system, without the development of any of the signs of irritation; in other cases, however, well-marked irritant symptoms have been present. Applied externally, it produces deep fistulous sores. Dyers not infrequently suffer severely on their arms when using it in the course of their trade. Death has resulted in *four hours* after its administration.

Treatment.—Emetics, magnesia, chalk, and demulcent drinks.

VEGETABLE IRRITANTS.

Mode of Action.—The general effects produced by the somewhat large class of vegetable irritants are—

a. Severe abdominal pain, accompanied with vomiting and purging.

b. Absence in most cases of any cerebral or nervous symptoms.

c. The irritant properties appear to reside in an acrid oil or resin.

In colchicum, stavesacre, and some others, the presence of an alkaloid may account for their active properties.

d. In medicinal doses the vegetable irritants act as safe purgatives.

e. The *post-mortem* appearances found in the alimentary canal betoken inflammation, the result of irritation.

f. Applied externally, they produce inflammation, pustular eruptions, and sometimes unhealthy callous sores.

SAVIN.

Juniperus Sabina. Nat. Ord. Coniferæ.

The leaves and tops of this plant yield an acrid volatile oil, to the presence of which the poisonous properties are due. The oil is colourless or pale yellow, with a peculiar terebinthinate odour. It is used in medicine both internally and externally, and is supposed to possess emenagogue properties. The dried powder is less active than the fresh tops. Savin is seldom used as a poison, more frequently to procure abortion. Its use for this purpose is mentioned in the old ballad of Marie Hamilton—

> 'The King has gane to the Abbey garden,
>   And pu'd the savin tree,
> To scale the babe frae Marie's heart;
>   But the thing it wadna be.'

Symptoms.—Those of irritant poisoning. Violent pain in the abdomen, followed by vomiting, and in some cases salivation and strangury. Purging is not always present. When taken to procure abortion, death often takes place before the object for which it was taken is attained.

Post-mortem Appearances.—The stomach, gullet, and intestines are found congested and inflamed. The stomach may in places be seen corroded, and a green powder adherent to its coats. The powder washed and dried, and then rubbed, gives off the odour of savin.

Analysis.—When an infusion or decoction of the leaves has been taken, chemical analysis is of no assistance. The oil may be separated from the contents of the stomach by subjecting them to distillation, and then shaking the distillate with ether, when the oil is dissolved out. On the evaporation of the ether the oil is left for examination. When the powder is taken, the contents of the stomach are not unlike green pea-soup. If a small portion of the green liquid be taken and diluted with water, the green chlorophyll, being insoluble, will sink; but if the colour be due to bile, the liquid will remain of an uniform green colour. A portion of the green matter collected, dried, and then rubbed in a mortar, the characteristic odour of savin will be given off. The microscope may detect bits of the twigs.

CROTON OIL.

The oil expressed from the seeds of *croton tiglium*. *Nat. Ord. Euphorbiaceæ.*

The seeds, when taken, produce violent pains in the stomach and purging. Pereira has described the case of a man who suffered severely from inhaling the dust of the seeds. The dose of the oil is from half a minim to a minim. Dr. Trail (*Outlines*, p. 151) mentions the case of a delicate lady patient who took three drops for a dose without inconvenience.

A medical friend informs me, that in Shetland six drops in as many colocynth pills have, in cases there, only produced 'a comfortable "*aisement*" of the bowels.'

This is attributed to the *dura ilia*, resulting from a constant fish diet.

The poisonous properties depend upon the presence of a fatty acid.

Symptoms.—Pain in the abdomen, vomiting, and purging, followed by exhaustion and collapse. In some cases, when the dose is large, the pain is hot and burning, and may be felt from the mouth downward.

Analysis.—Separate the oil from the contents of the stomach by means of ether, and then drive off the ether by means of heat. The oil then warmed with nitric acid becomes of a brown colour, and nitrous acid vapours are given off.

COLCHICUM.

Colchicum Autumnale (Meadow-saffron). Nat. Ord. Melanthaceæ.

The poisonous properties of this plant reside in an alkaloid *colchicina*, chiefly found in the corms, but also present in other parts of the plant. The seeds have caused death.

Symptoms.—Colchicum in medicinal doses increases the activity of the liver, and bile is freely secreted. The action of the kidneys and skin is also increased. The heart is also more or less affected, and its frequency is diminished. In large doses, all the symptoms of irritant poisoning are present.

Post-mortem Appearances.—Death may result from its use without leaving any morbid appearances. In other cases, however, the usual signs of inflammation were present.

Analysis.—Colchicina, obtained by Stass' process, added to concentrated nitric acid, becomes of a violet colour, changing to blue and brown.

Treatment.—Stimulants and opium should be given to counteract its depressing effects.

BLACK HELLEBORE.

Helleborus Niger. Black Hellebore. Nat. Ord. Ranunculaceæ.

This plant, also known as the Christmas rose, is the melampodium of the old Pharmacopœias. All parts of the plants are poisonous.

Symptoms.—Purging, vomiting, pain in the bowels, and cold sweats. Death is generally preceded by convulsions and insensibility.

Post-mortem Appearances.—Those common to the action of other irritants.

WHITE HELLEBORE.

Veratrum Album. Nat. Ord. Melanthaceæ.

White hellebore acts very much in the same manner as the black hellebore, but is more powerful. The powder causes violent sneezing. The alkaloid *veratria* appears to be the active principle. The symptoms and *post-mortem* appearances are analogous to those produced by black hellebore.

VERATRIA.

The alkaloid veratria is obtained from the dried fruit of *Asagræa officinalis.*

The alkaloid is in the form of a white amorphous powder, bitter and acrid to the taste. It acts as a powerful errhine, causing violent sneezing. Insoluble in water, it is readily dissolved by alcohol, ether, and chloroform. When gently heated on a plate with strong sulphuric acid, it first turns yellow, then crimson. Veratria is entirely dissipated by heat.

Two grains of the alkaloid killed a cat in one minute; a dog being destroyed in two hours by a dose of three grains.

The Symptoms and Post-mortem Appearances in man are the same as in poisoning by hellebore.

Treatment.—Stomach pump and emetics. Astringent infusions should be given, and alcohol and opium administered if the condition of the patient seems to require them.

GAMBOGE is the gum-resin of *Garcinia Morella.* It is an active ingredient in certain quack 'vegetable pills.' One drachm has caused death by its irritant action.

JALAP, the powder obtained from the tubers of *Exogonium purga.* The active properties of the drug reside in a resin. It is a drastic purgative, twelve grains having killed a dog.

SCAMMONY is obtained from the dry root of *Convolvulus scammonia.* Like the last mentioned, it is a powerful purgative, and may cause death if given in large doses to debilitated individuals.

CASTOR OIL.—The oil expressed, with or without the aid of heat, from the seeds of *Ricinus communis.* A girl eighteen years of age died in Liverpool in 1837 from eating a few of the castor-oil seeds.

ARUM MACULATUM — Cuckow-pint, Wake-robin, or Lords and Ladies—is one of the most acrid of indigenous vegetables. The active property of the plant appears to be lost by drying and by distillation in water. Children have been poisoned by its leaves.

YEW.—The twigs and fruit of *Taxus baccata* act as irritant poisons, several children having died after eating the fruit. *Post-mortem* signs of irritation of the alimentary canal.

LABURNAM.—*Cytisus laburnam,* or common laburnam, the seeds of which are poisonous. They con-

tain a narcotico-acrid, uncrystallizable alkaloid, producing vomiting, foaming at the mouth, and insensibility. Recovery took place in two cases, mentioned by Trail, from the use of emetics and ammonia.

FOOL'S PARSLEY—*Æthusa cynapium*—has been mistaken for parsley. Nausea, vomiting, giddiness, and severe abdominal pains are among the most common symptoms of poisoning by this plant.

BRYONY.—Two plants included under this name, *Bryonia dioica*, white bryony, *Nat. Ord. Cucurbitaceæ*, the only indigenous cucurbitaceous plant; and the *Tamus communis*, black bryony, *Nat. Ord. Dioscoreaceæ*. Both the bryonia dioica and the tamus communis possess active irritant properties. They are of importance from the fact of their growing wild, and the possibility of the fruit being eaten by children.

ELATERIUM, the inspissated juice of *Ecbalium Officinarum*, or Squirting Cucumber. It is a powerful drastic purgative, one grain having given rise to alarming symptoms in man.

ANIMAL IRRITANTS.

CANTHARIDES.

Cantharis vesicatoria. Nat. Ord. Coleoptera.

Cantharides is seldom given as a poison, but is most frequently employed to procure abortion, or for its supposed aphrodisiac properties.

Cantharides is a pure irritant. Applied externally, it produces vesication; and if absorbed, strangury.

Cantharidine, the active principle of cantharides, is insoluble in water and bisulphide of carbon. It is but slightly soluble in alcohol, but it is dissolved by chloro-

form, ether, and some oils. Four parts of cantharidine have been procured from a thousand parts of the flies.

Symptoms.—An acrid taste is first experienced in the mouth, followed by burning heat in the throat, stomach, and abdomen. There is constant vomiting of bloody mucus, and the stools also contain blood. The patient complains of intense thirst, pains in the loins, and an incessant desire to void urine, which is frequently mixed with blood. Salivation in some cases is a prominent symptom. Strangury may result from the external application of cantharides as a blister, etc. Priapism is often obstinate and painful. The fatal termination is generally ushered in by violent convulsions and delirium. In pregnant women abortion may take place as a result of the general irritation and disturbance of the system, there being no proof that the uterus is particularly affected by the drug. The vomited matters may contain shining green particles, the presence of which indicate the nature of the poison taken. The invasion of the symptoms may in some cases be retarded.

Post-mortem Appearances.—Those of powerful irritation. The mucous membrane of the whole alimentary canal from the mouth to the rectum has been found in a state of acute inflammation. The uterus, kidneys, and internal organs of generation share also in the general irritation, ulceration of the bladder having been met with in some cases. Portions of the wings and elytra are sometimes found adhering to the coats of the stomach.

Fatal Dose.—One ounce of the tincture has caused death in fourteen days. This is perhaps the smallest fatal dose on record. Six ounces have been stated to have produced no dangerous symptoms. The worthlessness of the preparation may account for this result.

Treatment.—Vomiting should be promoted, and warm mucilaginous drinks given. If vomiting is absent, emetics should be administered. Oil should

not be given, as it dissolves out the active principle. Opium may be given with advantage.

Analysis.—The contents of the stomach concentrated, and then treated with chloroform, and allowed to spontaneously evaporate. A portion of the residue placed on the skin, and the presence or absence of vesication noticed. Examined under the microscope, portions of the wing cases may be detected. No change of colour is produced in cantharidine by the action of sulphuric or nitric acids, thus distinguishing this substance from any of the vegetable alkaloids.

METHODS FOR DETECTING THE VEGETABLE ALKALOIDS.

There are several methods recommended for the isolation and detection of the vegetable alkaloids, and their separation from the contents of the stomach or from the membranes and tissues of the body. The process, however, most generally pursued is that of Stass, which may be briefly described as follows :—

1. The substance to be examined is mixed with twice its weight of absolute alcohol, to which from ten to thirty grains of tartaric or oxalic acid—preferably the former—have been added, and the mixture subjected to gentle heat in a flask.

2. If the membranes or organs have to be examined, they are finely divided, treated with absolute alcohol, squeezed, and again treated with fresh alcohol, as in 1.

In either case, the mixture, when quite cold, is filtered, and the alcoholic solution is concentrated by evaporation, either *in vacuo* or in a current of air not exceeding 95° F.

The liquid residue is now passed through a moistened filter, which separates the fat and other insoluble matters. The filtrate is evaporated to dryness over sulphuric acid or *in vacuo*, and the acid residue of this evaporation dissolved in the smallest

possible quantity of distilled water. The acid liquid is then *gradually* neutralized with the bicarbonate of potash or soda until effervesence ceases, and afterwards shaken in a flask with four or five times its bulk of pure ether, and allowed to settle. When the ether has become quite clear, a small portion of it is decanted into a small glass capsule, and allowed to spontaneously evaporate in a dry place. If during evaporation streaks of liquid appear on the side of the capsule, running together at the bottom, a liquid volatile alkaloid is probably present.

If none of these manifestations occur, the alkaloid is in all probability solid and non-volatile.

THE ALKALOID IS VOLATILE.

To the original mixture in a flask add a moderate quantity of a strong solution of caustic potash or soda, mixed with ether; agitate, and allow the mixture to settle. Pour off ethereal solution, and re-shake residue with a fresh quantity of ether; decant, and mix both solutions. The ethereal solution is now shaken with a mixture of four parts of water and one of sulphuric acid, which withdraws the alkaloid from its solution, leaving any fatty matter dissolved in the ether. The acid solution is now mixed with strong potash or soda solution in excess,[1] agitated with ether, the ether poured off, and then evaporated at as low a temperature as possible,[2] leaving the pure alkaloid with all its characteristic chemical and physical properties.

THE ALKALOID IS NON-VOLATILE.

To the original mixture in a flask add strong caustic potash or soda solution, and agitate, with successive portions of pure ether, allowing it to completely settle each time. The ethereal solutions being mixed, are evaporated, leaving the alkaloid in an impure state. To purify it, the solid residue left on evaporation is treated with a small quantity of dilute sulphuric acid, which dissolves the alkaloid, leaving any fatty impurities behind. The acid liquid is evaporated to three-quarters of its bulk over strong sulphuric acid, and then a saturated solution of carbonate of potash or soda added. Absolute alcohol will then dissolve out the pure alkaloid, giving it, on evaporation, in the crystalline form, and in a state to show its characteristic reactions.

[1] The sulphates of the alkaloids are insoluble in ether, hence they must be decomposed by an alkali.

[2] The temperature should be low, for the greater part of the conia will be evaporated with the ether.

Otto's Method.

Otto's modification of Stass' process is simpler, and at the same time equally accurate. Instead of the numerous treatments and evaporations which have to be gone through in the original process, Otto converts the alkaloid into a salt, such as the sulphate, by the addition of acid, and after solution in a small quantity of water, agitates with successive quantities of ether, which removes all foreign fatty matters, leaving the solution of the alkaloid comparatively pure, and from which the alkaloid may be obtained in a state of great purity.

Table showing the Characters and Tests of the following Poisons.

MORPHIA.	STRYCHNIA.	BRUCIA.	NARCOTINE.
1. Crystallizes in colourless transparent prisms, belonging to the trimetric system.	1. Crystallizes in white, four-sided prisms, terminated by four-sided pyramids.	1. Crystallizes in oblique rhomboidal prisms, sometimes agglomerated mushroom-like heads.	1. Crystallizes in right rhombic prisms, or in needles grouped in bundles, flattened, colourless, transparent, and lustrous.
2. Turns the plane of polarization to the left.	2. Rotates polarized light to the left.	2. Rotates polarized light to the left.	2. Deflects the plane of polarization to the left.
3. Narcotic poison.	3. Produces in most cases tetanic spasms.	3. Like strychnia, only less active.	3. Narcotic poison, though not so powerful as morphia.
4. Sulphuric acid and bichromate of potash give a bright-green coloration.	4. Treated with cold sulphuric acid and potassium bichromate, an intense purple colour is produced, becoming first red and then yellow.	...	...

5. Strong colourless nitric acid, added freely to a cold solution, produces a deep orange-red coloration.	5. Strong nitric acid usually produces a yellow or yellow-brown colour.	5. Strong nitric acid produces a blood-red colour.	5. Strong nitric acid acts violently upon it, giving off copious red fumes; a thick resinous matter is also formed.
6. A netural solution of the permuriate of iron gives a rich indigo-blue colour, turning to green in excess of the reagent.	...	...	...
7. Soluble in *liquor potassæ.*	...	...	7. Not dissolved by *liquor potassæ.*
8. Sulphuric acid and peroxide of lead, the free acid removed by addition of carbonate of lead, and the lead by sulphuretted hydrogen, the resulting fluid evaporated, a brown, slightly amorphous substance is formed — *morphetine.*	8. Dissolved in cold sulphuric acid, and peroxide of lead added, a blue colour is formed, becoming violet, then red, and lastly yellow.	8. Boiled with sulphuric acid and peroxide of lead, a reddish-brown mass is formed.	...

Stass' process cannot be recommended for the detection of opium in organic liquids, for two reasons. Firstly, that it altogether fails to indicate the presence of meconic acid; and secondly, because morphia is almost insoluble in ether.

The method recommended by Taylor may be briefly described as follows :—

The liquid—porter, etc.—to be examined is acidified with acetic acid; or if a solid organ is to be tested, it must be cut into thin slices and placed in distilled water acidified in a similar way. In either case the liquid is digested for one or two hours at a gentle heat, and filtered. Acetate of lead is now added to the filtrate until no further precipitation occurs; the liquid is then boiled and filtered. The meconic acid remains on the filter as meconate of lead, while the filtrate contains the morphia as acetate. The liquid is freed from excess of lead by passing through it a current of sulphuretted hydrogen, filtered to remove the precipitated sulphide of lead, and the resulting liquid evaporated to an extract on a water bath, and treated with alcohol. The alcoholic solution on evaporation gives acetate of morphia, which may then be tested.

The meconate of lead which remained on the filter is decomposed by treating it with dilute sulphuric acid, and gently boiling the mixture. The filtered liquid should be neutralized before the tests for the presence of meconic acid are applied.

The reactions of both morphia and meconic acid are best seen from the following table :—

Morphia—Solid.

Treated with strong nitric acid,	Dissolves with effervescence and the production of ruddy fumes, forming a rich orange-coloured solution.
Mixed with a little iodic acid and starch paste,	A blue colour.
Dissolved in cold strong sulphuric acid, and a drop of strong solution of bichromate of potash added,	Bright green colour.

Morphia and Meconic Acid in Solution.

	MORPHIA.	MECONIC ACID.
Tested with litmus paper,	Slightly alkaline.	Very distinctly acid.
A little perchloride of iron, rendered as nearly neutral as possible,	An inky blue colour, destroyed and changed to orange-red by nitric acid.	Deep red colour, not easily destroyed by a solution of corrosive sublimate or dilute mineral acids.

The characteristic tests for morphia are its reaction with nitric acid, iodic acid and starch, and perchloride of iron. The reaction with the perchloride of iron is also characteristic of meconic acid. This last mentioned test is a very conclusive one for meconic acid, when certain precautions are taken; for the property of striking a deep red with a persalt of iron is shared equally by sulphocyanides and alkaline acetates. The colour produced by sulphocyanic acid *is instantly bleached* on the addition of *corrosive sublimate.* The

question thus lies between acetic and meconic acid. To distinguish the one from the other, the solution to be tested should be boiled for a short time after the addition of a few drops of sulphuric acid. Any acetate present is decomposed, and the acetic acid is expelled by the boiling; so that if, after allowing the solution to cool, it still gives the red colour with perchloride of iron, the reaction may be taken as conclusive of meconic acid. By these means morphia and meconic acid may be detected in porter and other liquids.

NARCOTIC POISONS.

SOMNIFEROUS.

OPIUM.

Opium is the inspissated juice of the *Papaver somniferum*, the Garden or Opium Poppy. The plant is a native of Egypt and Syria, cultivated in England.

Opium is sometimes taken in its crude state as a poison, but more frequently one of its preparations is thus employed, notably the tincture, better known as LAUDANUM. The poisonous properties of this drug reside in an alkaloid, *morphia*, in combination with an acid, *meconic acid*. The several varieties of opium vary considerably in the quantity of morphia which they contain, the amount varying from two to nine per cent.

Of all forms of poisoning, that by opium and its preparations is most frequent; and it is stated that three-fourths of all the deaths from opium occur among children *under five years of age*.

Symptoms.—The rapidity with which the symptoms of poisoning by opium make their appearance will

depend upon the form in which the poison is taken; solution, of course, increasing the activity of the drug. In most cases an interval of from half an hour to an hour elapses after the poison has been swallowed before any evil effects become apparent. Christison, however, mentions a case in which stupor did not show itself for eighteen hours. During the first stage of poisoning by opium the patient may become slightly excited; this state is, however, soon followed by giddiness and drowsiness. The eyes are kept open with difficulty. Stupor and insensibility now supervene, from which he may in most cases be temporarily aroused by a loud noise or a smart blow. As the case progresses, coma and stertorous breathing occur, and it becomes almost impossible to rouse him at all. The pulse, at first small, quick, and irregular, becomes slow and full as the coma increases. The breathing, hurried in the early stages, is now slow and stertorous. The pupils are contracted or dilated; the former condition is in most cases most frequently present, together with insensibility to light. The pupils may be contracted in ureamic coma in Bright's disease; the nature of the case will be explained by the history and presence of dropsy. All the secretions, except that of the skin, are suspended, and the bowels are usually obstinately confined. The breath may be impregnated with the odour of opium. Certain anomalies in the symptoms may occur; thus, there may be vomiting and purging, convulsions—most frequent in children—delirium, tetanic spasms, one pupil dilated and the other contracted, paralysis and anæsthesia. It must be borne in mind that remissions sometimes occur in the symptoms, the patient dying after an attempt at recovery.

A question of some importance may arise as to the amount of volition and power of locomotion which may exist for some time after a poisonous dose has been taken. Death may be due to causes other than the

effect of poison. It must, at least, be admitted as possible, that a person, after swallowing a quantity of opium sufficient to cause death, may yet be able to walk and move about for from one to two hours.

Opium-eating.—If opium be taken for some time in small doses, the system becomes tolerant of it, so that a dose which would be poisonous to most people, only produces a slight and pleasurable excitement. De Quincey was in the habit of taking daily nine ounces of laudanum. The habitual opium-eater generally suffers from disorders of the disgestive organs, dyspepsia, and its train of unpleasant symptoms; the body becomes thin, the countenance attenuated, the eyes sunken and glassy, the gait halting, and the body bent. The craving for the drug becomes greater and greater, which is only temporarily satisfied by larger and larger doses. The opium-eater seldom attains a great age, usually dying before forty. This is perhaps a somewhat exaggerated picture of the ill effects of opium-eating. Christison, after quoting the results of his observations in twenty-five cases of confirmed opium-eaters, concludes as follows:—'These facts tend on the whole rather to show that the practice of eating opium is not so injurious, and an opium-eater's life is not uninsurable, as is commonly thought; and that an insured person, who did not make known his habit, could scarcely be considered guilty of concealment to the effect of voiding his insurance. But I am far from thinking—as several represent who have quoted this work—that what has now been stated can with justice be held to establish such important inferences; for there is an obvious reason why in an inquiry of this kind those instances chiefly should come under notice where the constitution has escaped injury, cases fatal in early life being more apt to be lost sight of, or more likely to be concealed.'

Effects of External Application.—The application of opium to the surface of the body is not usually

attended with dangerous symptoms; but in a few cases, due probably to some idiosyncrasy, alarming effects or even death has resulted from the external application of the drug. Orfila has tried to show that opium is more readily absorbed by the coats of the rectum, and that it acts more rapidly than when taken into the stomach. This statement does not appear to be correct, for the dose administered by enema is usually twice that given by the mouth.

Post-mortem Appearances.—As might be expected, the appearances found after death are not very characteristic. The vessels of the brain are congested, and serous effusion in the ventricles or between the membranes is not uncommon. Engorgement of the lungs is most frequently present in those cases in which convulsions have occurred. The stomach is in most cases found quite healthy. The bladder may be full of urine, due probably to the persons being unable to empty it from loss of consciousness.

Fatal Period.—From three-quarters of an hour and upwards.

Fatal Dose.—Four grains is about the smallest fatal dose in an adult, but recoveries after taking an ounce or more of laudanum are not very rare.

Treatment.—The stomach pump should be used without delay, and the stomach thoroughly washed out. Emetics should also be given if the patient can swallow. The administration of strong coffee or tea, the application of ammonia to the nostrils, flagellation of the soles of the feet, and keeping the patient constantly walking about, are among the measures usually adopted by way of treatment. Galvanism and artificial inflation of the lungs have done good service even in the most hopeless cases. Vinegar should not be given, as it dissolves the morphia and renders it more easy of absorption. Death is rare in those cases in which proper remedies have been resorted to before the stupor commenced.

Table showing points of distinction between Apoplexy and Narcotic Poisoning.

APOPLEXY.	NARCOTIC POISONING.
1. Apoplexy *may* be preceded by premonitory symptoms, giddiness, headache, noises in the ears, and partial paralysis.	1. No premonitory symptoms, except by fortuitous combination.
2. Apoplexy chiefly attacks the old, and is very rare in young people.	2. More frequently in the young, especially of the female sex.
3. Most frequently among fat people.	3. In fat or thin people.
4. Symptoms may come on during the meal or *immediately* after.	4. An interval of from ten to thirty minutes always occurs, even in the case of opium, the commonest of narcotic poisons.
5. Symptoms commence abruptly, sometimes with deep stupor.	5. Symptoms advance gradually.
6. Patient is with difficulty, if ever, temporarily aroused. Convulsions common. Face bloated. Pupils *dilated.*	6. Patient may be roused from the deepest lethargy if shaken or spoken to in a loud voice. Convulsions rare in opium poisoning. Face seldom bloated. Pupils *contracted.*
7. Life may be prolonged for a day or more. Apoplexy *may*, however, kill in an hour.	7. Life seldom prolonged beyond six or eight hours. Shortest time in which opium has caused death, *three* hours.
8. No response when the forehead is smartly tapped with the finger-nails, or when water is injected into the ear.	8. The patient may be roused by tapping the forehead, etc.

Synopsis of the effects of Opium upon the System.

1. *The Mental Faculties.*—The first effect noticed when opium is taken in small doses is a primary exaltation

of the mental faculties; the imagination is rendered brilliant, and the passions exalted; after a time the usual drowsiness supervenes, followed by deep sleep. A dose of thirty drops of the tincture caused in one experimenter an exhilaration of the mental faculties, and an aptitude for study; the subsequent drowsiness being removed by a dose of a hundred drops or more, when the greatest mental excitement was the result.

2. *The Respiration.*—The frequency of the respirations is diminished, and the oxidation of the blood impaired.

3. *The Pulse.*—The first effect on the circulatory system is that of a stimulant, and then sedative. By the administration of repeated small doses the force of the circulation may be maintained for some time.

4. *The Eyes and Countenance.*—The pupils, when the patient is powerfully under the influence of opium, are contracted even to a point. Dilatation has, however, been noticed in some cases.

The countenance is placid, pale, and ghastly; the eyes heavy, and the lips livid.

5. *The Cutaneous System.*—The skin, although cold, is not infrequently bathed in profuse perspiration.

6. *The Alimentary Canal.*—Sometimes there is vomiting and even purging; but as a rule the secretions along the whole alimentary canal are diminished, and constipation is the result.

7. *The Average Commencement of Symptoms.*—Much depends upon the size and form of the dose. In most cases the first appearance of the symptoms is seldom delayed beyond an hour after the poison is taken.

8. *Average Period of Death.*—Seven to twelve hours.

DELIRIANTS.

Under this head will be noticed those poisons whose action on the animal economy is characterized

by *delirium*, illusion of the senses, and marked *dilatation* of the pupil. In some cases there is considerable irritation of the digestive organs, accompanied with a difficulty to pass water, sometimes ending in complete suppression of urine.

The following are among the most important poisons of this group :—

1. Belladonna.	4. Solanum Dulcamara.
2. Hyoscyamus.	5. ,, Nigrum.
3. Stramonium.	6. ,, Tuberosum.

Those of less importance are :—

1. Œnanthe Crocata.	4. Lolium Temulentum.
2. Camphor.	5. Certain Poisonous Fungi.
3. Cocculus Indicus.	

BELLADONNA.

Atropa Belladonna. Nat. Ord. Solanaceæ.

Taken internally or applied externally, belladonna causes dryness of the mouth and throat, with intense thirst. Nausea and vomiting are present in most cases, accompanied with giddiness, double or indistinct vision, active delirium, convulsions ending in stupor and coma. A very marked characteristic of poisoning by solanaceous plants is *dilatation of the pupil*, the iris in some cases being reduced to a mere line round the pupil. The symptoms in some cases which have been recorded are almost identical with those of delirium tremens. In other instances there has been little or no delirium, the patient at once passing into fatal lethargy. Alarming symptoms have followed from drinking a decoction of belladonna leaves, which were mistaken and supplied for those of the ash.

Post-mortem Appearances.—Congestion of the vessels of the brain, sometimes with fluid blood, at other times with thick black blood. The stomach

may or may not be congested; but in cases where the ripe berries have been taken, the mucous lining may be seen deeply dyed by the juice of the berries. The pupils are usually found dilated.

Treatment.—Emetics and purgatives, castor-oil and animal charcoal. The symptoms as they present themselves must be treated on general principles.

Table showing some of the Symptoms and Effects of Opium and Belladonna.

OPIUM.	BELLADONNA.
1. Slight excitement, coma, lethargy, and no return of the excitement should the patient recover.	1. Active, busy delirium preceding the coma, followed by delirium, if recovery takes place.
2. Coma is of shorter duration than in poisoning by belladonna.	...
3. Pupils contracted.	3. Pupils dilated.
4. Local application to the eye does not affect the pupil.	4. Dropped into the eye, pupils are dilated.
5. Bowels as a rule confined.	5. Bowels not affected.
6. Acts powerfully on children.	6. Well borne by children.

N.B.—Belladonna has been stated to act in antagonism to opium, and its administration recommended in poisoning by that drug.

HYOSCYAMUS.

Hyoscyamus Niger. Nat. Ord. Solanaceæ.

Hyoscyamus, or Henbane, taken in large doses, produces symptoms not unlike those due to belladonna. There is the same affection of sight,—double vision,—the same dilatation of the pupils, delirium, confusion of thought, insensibility, and coma. A

form of mania, with wild hallucinations, has sometimes been observed to follow the administration of this drug.

The peculiar property of henbane is marked by its tendency to produce a general paralysis of the nervous system. The root has been eaten by mistake for parsnips, when all the symptoms above mentioned were present. The seeds are more poisonous than the roots, the leaves being the lest poisonous of the plant.

Post-mortem Appearances.—The morbid appearances are not unlike those which result from poisoning with belladonna.

Fatal Dose.—Nothing certain can be stated as to the amount required to cause death. Alarming symptoms are said to have followed the administration of ten minims repeated every six hours. Twenty *seeds* have caused active delirium. Idiosyncrasy may have something to do with this result.

Treatment.—Emetics and purgatives, to expel the poison from the system.

STRAMONIUM.

Datura Stramonium. Nat. Ord. Solanaceæ.

The thorn apple possesses powerful poisonous properties. These are marked by the production of giddiness, impairment of vision, and syncope. Furious delirium is not infrequent; and in one case where this state was present, there was loss of speech. The face is usually flushed, the eyes glistening and restless, and the pupils dilated; in short, the countenance is that of one intoxicated. Taken together, the symptoms are not unlike those produced by belladonna. Poisoning by stramonium seeds is a favourite mode of procedure among the Hindoos; but as the poison is most frequently given to facilitate robbery, death

seldom results from its use. The outward application of the leaves may give rise to all the appearances of poisoning.

The active principle of stramonium is the alkaloid *datura*, which crystallizes in quadrangular prisms, colourless, and with a bitter acrid taste. It resembles atropia and hyoscyamia in chemical properties.

Post-mortem Appearances.—Congestion of the vessels of the brain and the membranes, with some slight gastric irritation.

Treatment.—Emetics and purgatives, to get rid of the portions of the plant swallowed.

Some other solanaceous plants—*Solanum dulcamara*, Bitter Sweet or Woody-nightshade, *Solanum nigrum* or Garden-nightshade, and the *Solanum tuberosum* or Potato—possess poisonous properties. They, like the other members of the order to which they belong, give rise to symptoms characterized by giddiness, dimness of sight, trembling of the limbs, and delirium. The water in which the potato has been boiled is sometimes used by the vulgar as an application to favus of the scalp. The active principle of these plants resides in an alkaloid—*solania*—which is not a very powerful poison. A rabbit was killed in a few hours by two grains of the sulphate of solania.

ŒNANTHE CROCATA.

Hemlock, Drop-wort, or Dead-tongue, is a poisonous, indigenous, umbelliferous plant.

Accidental poisoning by this plant has occurred. The symptoms in one of the cases which have been recorded, were those of *delirium tremens;* in another, which terminated fatally, vomiting of blood, followed by convulsions: first contraction and then dilatation of the pupil, spasmodic respiration, and an almost

imperceptible pulse, were the effects noticed. Death may take place in a few hours.

Post-mortem Appearances.—Congestion of the vessels of the brain, and gastric irritation. The face has sometimes a bloated expression, and blood may escape from the ears and mouth.

Treatment.—Purgatives and emetics, to evacuate the stomach, and thus get rid of the poison.

CAMPHOR.

Camphora Officinarum. Nat. Ord. Lauraceæ.

Camphor is a concrete vegetable oil. In large doses, this substance is poisonous; but only one case is recorded of its use for this purpose. The symptoms are languor, giddiness, and delirium.

Post-mortem Appearances.—Those produced by irritants.

Treatment.—Free purgation and emetics, to empty the stomach.

COCCULUS INDICUS.

The fruit of *Anamirta paniculata. Nat. Ord. Menispermaceæ.*

Cocculus Indicus is poisonous, and is frequently used by poachers to capture fish. The berries are ground to powder, mixed with bread, and then thrown into the water. When taken by the fish, they become stupefied, float to the surface, and are then taken.

The poisonous properties are due to a crystalline alkaloid, picrotoxia. Fraudulent publicans have used this drug for the adulteration of beer. The strength of the beer is first reduced by the addition of salt and water, and then the cocculus indicus is added, to give to it an intoxicating property. The effects produced

on the unfortunate customers are a strong desire to sleep, with more or less wakefulness. Loss of voluntary power is present, but consciousness is not lost, the sufferer lying in a state bordering on nightmare. Cocculus is not used in medicine or the arts, and yet a large quantity is imported, and mysteriously disappears in this country.

The symptoms which have been noticed in poisoning by this substance are nausea, vomiting, severe abdominal pains, stupor, and intoxication. Two deaths at least have been reported as resulting from it. In the case of *R.* v. *Cluderay*, Archibold's Crim. Cases, 604, 'the defendant administered to a child two cocculus indicus berries, entire in the pod, with intent to murder the child. The kernel is a poison; the pod is not, and will not dissolve in the stomach; and they were therefore harmless. This was held to be administering of poison with intent to murder, within this section.'

Picrotoxia.—The alkaloid is in fine white crystals, intensely bitter to the taste. Soluble in boiling water; slightly so in cold. Alcohol and ether readily dissolve it. In organic liquids it might be mistaken for sugar, or *vice versa*, as it precipitates the oxide of copper when boiled with the sulphate and potash.

LOLIUM TEMULENTUM.

The seeds of *Lolium Temulentum*, or common Darnel, are poisonous. Cases of poisoning have occurred from these seeds being accidentally ground with wheat or rye, and then made into bread.

The symptoms are gastric irritation, nausea, and vomiting, followed by giddiness, deafness, loss of vision, and in some cases delirium. Not infrequently the symptoms resemble those produced by ergot. No death has been recorded as resulting from the use of

these seeds. Three ounces of paste made from darnel flour, given to a dog, did not cause death.

POISONOUS FUNGI.

Poisoning by mushrooms is by no means rare, as the result of accident. The *Agaricus campestris* and a few others are edible; but it is a fact worthy of notice, that the poisonous properties of mushrooms are modified by climate and the seasons of the year at which they are collected. Idiosyncrasy may have something to do with the injurious effects produced on some persons by the fungi.

The *Agaricus campestris*, or common mushroom of this country, is sometimes poisonous; and in some countries—Italy and Hungary—it is usually avoided. In Russia and in France certain fungi are eaten which are regarded as poisonous by us.

Bentley gives, in his *Botany*, the following table, by which edible and poisonous mushrooms may be known:—

EDIBLE.	POISONOUS.
1. Grow solitary, in dry airy places.	1. Grow in clusters in woods and dark, damp places.
2. Generally white or brownish.	2. Usually with bright colours.
3. Have a compact, brittle flesh.	3. Flesh tough, soft, and watery.
4. Do not change colour, when cut, by the action of the air.	4. Acquire a brown, green, or blue tint, when cut and exposed to the air.
5. Juice watery.	5. Juice often milky.
6. Odour agreeable.	6. Odour commonly powerful and disagreeable.
7. Taste not bitter, acrid, salt, or astringent.	7. Have an acrid, astringent, acid, salt, or bitter taste.

Two sets of symptoms may follow the use of mushrooms as food—those of irritant and of narcotic poison-

ing. In the latter class, giddiness, double vision, and even delirium, have been present. In some cases, the individual has presented all the appearances of intoxication. Nausea, vomiting, purging, and convulsions characterize those of the former class. The *post-mortem* appearances will depend to a great extent upon the character of the symptoms prior to death. If signs of irritation have been present, inflammation of the stomach and bowels will most probably be found; but if, on the other hand, narcotic symptoms were predominant, congestion of the vessels of the brain will most likely be present. Arsenic and other poisons have been mixed with mushrooms with intent to kill; the probability of this occurring should be borne in mind, and a rigid examination of the contents of the stomach made in all doubtful cases.

Treatment.—Castor-oil and emetics.

INEBRIANTS.

The poisons grouped under this head are characterized by causing delirium, followed by narcotism. Recovery is not infrequently slow, the system suffering more or less severely from the effects of the poison. In the case of alcohol, loss of appetite accompanied with considerable gastric irritation are among the after effects of the poison.

The chief of this group are—

Alcohol, Ether, and Chloroform. Others of less importance will be briefly considered.

ALCOHOL.

It will be necessary to consider poisoning by this substance under two forms, acute and chronic. So many anomalies present themselves, that it is difficult to give a clear outline of the symptoms.

ACUTE.

In most cases the symptoms come on within a few minutes after the poison is swallowed. Giddiness, confusion of ideas, and a difficulty in walking straight, are among the first effects produced, these being followed by stupor and coma. Nausea and vomiting are the early signs of recovery. In some cases there may be *no* premonitory symptoms, sudden and complete stupor supervening some time after a large dose of alcohol had been taken.

The patient not infrequently recovers from the first symptoms. A relapse takes place; he becomes insensible, and dies convulsed. The countenance wears a vacant expression: the face flushed and bloated, the lips livid, and the pupils dilated and insensible to light. The sensibility of the pupil to the action of light should be regarded as a favourable symptom. The rapidity with which alcohol acts is not so great as to prevent the individual from walking some distance and performing certain acts of volition. The rapidity with which the symptoms show themselves will depend upon the previous habits of the individual, the strength and quantity taken. Alcohol, when diluted, induces a preliminary stage of excitement, then followed by stupor; but when concentrated, stupor may come on almost immediately the spirit is drank.

CHRONIC.

The habitual dram-drinker suffers from many diseases. The appetite becomes impaired; there is considerable irritation of the stomach and bowels, marked by vomiting and purging. Then follows a long list of organic diseases. The structure of the liver becomes changed: it may increase in size, become lighter in colour, and is then known as *nutmeg* or *dram-drinkers' liver.* Jaundice and dropsy may be present as the result of this altered condition of the gland. The kidneys also suffer from granular degeneration. Then follows a long series of nervous complaints: congestion of the brain, paralysis, *delirium tremens,* and insanity. Sudden death by coma not infrequently ends the

The vapour of alcohol may act as a poison, giving rise to the symptoms above mentioned. Congestion of the lungs or brain, or both together, is in most cases the cause of death in acute poisoning by alcohol.	career of the drunkard. *Delirium tremens* is the most common result of the habit of drinking; and this disease, it is stated, may be induced by the sudden discontinuance of alcohol in those who are habitually given to its use.

Post-mortem Appearances.—The stomach may present the usual signs of inflammation, due to the irritant action of alcohol. The colour of the mucous membrane of the stomach may be bright red, dark red, brown, or quite pale. The brain and its membranes are sometimes congested, and the intercranial vessels gorged with blood. The odour of alcohol may be present in the contents of the stomach, and may in some cases be detected by its odour in the lungs, brain, and other organs of the body. The lungs are not infrequently found congested, and the right cavities of the heart full of dark-coloured blood. Casper examined a case in which the cavities of the heart were empty. The blood is remarkably fluid, and of a dark colour. 'Lymphatic exudation between the cerebral meninges, so that the pia mater upon the cerebral hemispheres is seen here and there whitish and as if varnished, is not a result of death from drinking, but is the gradual result of the chronic irritation of the brain by habitual drunkenness, and is therefore a very common appearance in the bodies of all drunkards, from whatever cause they have died.' One other condition occurring in those dying from the effects of alcohol, is the remarkable long-continued presence of the *rigor mortis*, and perfect freedom from putrefaction, even up to the ninth day, in an atmo-

sphere by no means unfavourable to early decomposition. A condition of the skin known as '*cutis anserina*,' or goose skin, was present in some of the cases examined by Casper.

Absorption and Elimination.—From experiments on animals, it has been shown that alcohol is rapidly absorbed and then eliminated from the system, and that all traces of alcohol may disappear in a few hours, and yet death be the result of its action. Elimination takes place chiefly by the lungs. Alcohol is supposed to be decomposed in the lungs by the inhaled oxygen, carbonic acid and water being formed, with slight traces of acetic acid.

Fatal Period.—Death has occurred in a few minutes after a large dose of alcohol had been swallowed. The average fatal period is about twenty-four hours. Death may also be an indirect result of the action of alcohol on the system.

Fatal Dose.—Uncertain. The age and habits of the individual must be considered. Between three and four ounces proved fatal in a boy seven years of age.

Treatment.—Immediate use of the stomach pump and emetics, to empty the stomach. Cold affusion of water to the head, or the injection of cold water into the ears, may be tried. The administration of ammonia, and the employment of galvanism, have been of service in some cases.

Table showing points of distinction between Concussion of the Brain, Alcoholic Poisoning, and Poisoning by Opium.

CONCUSSION OF THE BRAIN.	ALCOHOL.	OPIUM.
1. Marks of violence on the head.	1. Absence of marks of violence, unless the person has fallen on the ground. The history of the case will help in forming an opinion.	1. Same as under alcohol.
2. Stupor comes on suddenly.	2. Excitement previous to the stupor, which comes on suddenly.	2. Symptoms slow in appearing, drowsiness, stupor, lethargy. The muscles are relaxed, and locomotion impossible. Patient may be roused by a sharp question.
3. Face pale and cold; the pupils sluggish and insensible to light, sometimes dilated.	3. Face flushed and pupils generally dilated.	3. Face pale, pupils contracted.
4. Remissions are rare, the patient recovering slowly, with some confusion of ideas.	4. Partial recovery may take place, followed by death after the lapse of some hours.	4. Remissions are rare in this form of poisoning.
5. Absence of odour of alcohol in breath. Odour of alcohol, if present, probably due to treatment of bystanders.	5. Presence of the odour of alcohol in the breath.	5. Odour of opium in the breath.

Analysis.—Tests for alcohol :—

1. Characteristic smell.
2. It dissolves camphor.
3. Treated with dilute sulphuric acid and a strong solution of bichromate of potash, the green oxide of chromium is set free, and the vapour of *aldehyd* may be detected by the smell.
4. Burnt under the mouth of a test tube moistened with solution of baryta or lime water, a deposit is formed in the tube of carbonate of baryta or lime.

Alcohol in the contents of the Stomach or in the Tissues.—The contents of the stomach, or the tissue bruised and macerated in distilled water, should be carefully distilled in a water bath. It will be necessary to neutralize the liquid prior to distillation. The distillate should be mixed with chloride of calcium or anhydrous sulphate of copper, and re-distilled. The liquid thus obtained is shaken with dry carbonate of potash, and allowed to settle. The alcohol rises to the top of the mixture, whence it may be removed by the aid of a pipette, and tested as before mentioned.

ETHER.

Ether, when taken in its liquid form, produces symptoms and *post-mortem* appearances not unlike those caused by alcohol.

Fatal Dose.—No death having been recorded, the fatal dose of this substance is unknown.

Ether Vapour.—The vapour of ether has caused death ; the fatality from this source having increased of late years owing to the employment of ether as an anæsthetic. Entering the blood through the lungs, it acts with great rapidity, a state of lethargy being quickly induced.

The early symptoms are noticed in a modification

of respiration, the breathing becoming slow, prolonged, and stertorous. The face is pale, the lips bluish, and the surface of the body cold and exsanguine. The pulse, at first quickened, becomes slower as the inhalation of the vapour is continued. The pupil is dilated, and the eye glassy and fixed. The voluntary muscles of the body become flabby and relaxed; the patient still, however, having the power to move the limbs. The involuntary muscles are not affected; as an instance, the uterus contracts and expels its contents with ease. If the inhalation of the vapour be pushed too far, the pulse sinks and coma ensues, from which the patient can only with difficulty be aroused; but if in an early stage the ether be discontinued, the patient rapidly regains consciousness, due to the rapid elimination of the ether by the lungs. A marked peculiarity in this form of poisoning is the complete anæsthesia or paralysis of the nerves of sensation.

Post-mortem Appearances.—These were chiefly found in the brain and lungs, which in most cases were greatly congested. The cavities of the heart have been found full of dark-coloured liquid blood. A marked effect noticed in poisoning by ether, is the congestion of the vessels of the upper portion of the spinal cord. The liver, kidneys, and spleen are sometimes congested.

Treatment.—When the pulse becomes weak, and the breathing laboured and stertorous, the inhalation should be discontinued, and cold water dashed in the face,—free ventilation being also allowed. Galvanism and artificial respiration should also be tried.

Analysis.—The contents of the stomach and tissues must be treated and distilled as described under alcohol.

Tests:—

1. The vapour passed into a solution of bichromate of potash, and sulphuric acid added, gives the reaction of alcohol.

2. The vapour burns with a smoky flame, depositing carbon on any cool surface placed above the flame.
3. It is but sparingly soluble in water, on which liquid it floats.

CHLOROFORM.

The effects produced by chloroform when swallowed, are not unlike those occasioned by alcohol. Four ounces have been taken without causing death; it is therefore not an active poison in this form.

Chloroform Vapour.—The symptoms occasioned by chloroform when inhaled, are not unlike those caused by ether, with this exception, that insensibility and general relaxation of the muscles is more rapidly produced.

Post-mortem Appearances.—Congestion of the vessels of the brain, and also of the lungs, is generally found. The cavities of the heart are usually empty; but, in some cases, the right side of the heart is found distended with dark-coloured fluid blood. Congestion of the spleen, liver, and kidneys is not of infrequent occurrence.

Fatal Period and Dose.—In one or two cases where the vapour was inhaled, death took place in from one to two minutes. Thirty drops thus taken destroyed life in one minute, and even fifteen drops have proved speedily fatal. It has thus destroyed life in a smaller dose, and more rapidly, than any other known poison.

Treatment.—The same as recommended with regard to ether.

Analysis—

Detection of Chloroform in the Blood and Tissues.

In searching for the presence of this substance in the blood or tissues, the examination should be made

as speedily as possible, as chloroform seems to have a great tendency to pass into formic acid, and to thus escape recognition.

The substance to be examined should be placed in a flask, to which is adapted a glass tube bent at right angles. A piece of blue litmus paper, and another portion of paper moistened with iodide of potassium and starch paste, are inserted into the end of the glass tube. The flask and its contents should be now placed in a water bath heated to a temperature of 160° F., and a portion of the glass tube just past the bend heated to redness. Any chloroform vapour evolved from the contents of the flask is decomposed during its passage through the heated glass tube into free chlorine and hydrochloric acid, the presence of the former being indicated by the starch paper becoming blue, while at the same time the reddening of the litmus paper reveals the presence of the acid. As a further corroboration, the exit tube may be made to dip into nitrate of silver solution, when a precipitate of the curdy white chloride of silver will take place, insoluble in nitric acid, but dissolving on the addition of ammonia.

CHLORAL HYDRATE.

This substance has only been introduced to the medical profession within the last year or two. It is prepared by acting on alcohol by chlorine.

Symptoms.—The symptoms which follow within a short time after the drug has been swallowed are marked by deep sleep, followed, if the dose be very large, by loss of consciousness. The pulse may be quickened and the face flushed; but in other cases the pulse became almost imperceptible, the face pale, and the breathing performed at long intervals. In a case described by Dr. Levinstein, and recorded in the *Lancet*, Feb. 21, 1874, the patient took six drachms

with intent to commit suicide. The face was at first flushed, then livid; the pupils contracted, and at times the circulation appeared to be entirely arrested. The temperature varied from 32·9 C. to 38·7 C.

The treatment in this case consisted in the use of galvanism, frictions, mustard plasters to the calves of the legs, and the injection of a solution of nitrate of strychnia. The man ultimately recovered. A peculiar eruption, not unlike that produced by shell-fish—and which I was the first to describe—sometimes occurs when this substance has been given for some time in medicinal doses.

It is said to act by becoming changed into chloroform and formic acid in the blood, due to the alkalinity of the latter.

Analysis.—Chloral is not inflammable. If potash be added to a boiling solution of chloral, it becomes decomposed with effervescence into chloroform and formic acid, and formate of potash is formed. Boiled with chloride of gold or nitrate of silver, the metals are precipitated on the addition of potash. A salt of copper is decomposed in a manner not unlike grape sugar.

Detection in the Tissues, etc.—Being decomposed in the blood into chloroform, it can only be detected by the means already described for the detection of that substance, the liquid being first rendered alkaline with potash. See p. 230.

NITRO-BENZOLE, OR ESSENCE OF MIRBANE.

Prepared by acting on benzole by nitric acid. Nitro-benzole is a heavy, yellow, oily substance, with a strong odour of bitter almond oil, from which, however, it differs by undergoing no change of colour when agitated with strong sulphuric acid. The natural oil acquires a fine crimson colour when treated with strong sulphuric acid.

Symptoms.—The vapour is more powerful than the liquid. In some cases which have been described, the patient has complained of pain in the head, giddiness, faintness, distorted vision, drowsiness ending in coma and death. The face is flushed, the jaws sometimes spasmodically closed, and the lips livid. Symptoms not unlike those produced by the essential oil of bitter almonds have been noticed in one or two cases. Rapidly fatal cases might be mistaken for apoplexy, but the odour betrays the cause of death.

Post-mortem Appearances.—Nothing very characteristic is found after death due to this poison. The blood is sometimes black and fluid, the lungs congested, and the liver of a purple colour. The blood contents of the stomach and even the tissues may smell strong of this substance.

Analysis.—Nitro-benzole may be separated by dis tilling the organic mixture with sulphuric acid, when the distillate will contain the poison if present. On account of its odour, the only substance with which it can be confounded is the essential oil of bitter almonds, which owes its poisonous properties to the prussic acid it contains.

The following table may assist in its detection :—

	NITRO-BENZOLE.	OIL OF BITTER ALMONDS.
Strong sulphuric acid,	No change of colour.	Rich crimson colour.
Proto-sulphate and persulphate of iron, liquor potassæ, and hydrochloric acid,	No blue colour.	Prussian blue.

ANILINE

is not unlike nitro-benzole in its action. The vapour causes giddiness and other signs of intoxication. Workers in this substance are said by Dr. Kruiser to suffer from bronchitis, cough, and ulceration of the scrotum and limbs. In dyers ekzema of the skin is sometimes found.

Analysis.—Soluble in alcohol and ether, but not in chloroform. A white insoluble compound is formed when added to dilute sulphuric acid. Heated with corrosive sublimate, a rich crimson colour is produced.

SEDATIVE.

CARDIAC.

DIGITALIS.

Digitalis Purpurea. Nat. Ord. Scrophulariaceæ.

The common Foxglove grows wild in the hedges in the south of England. All parts of the plant are poisonous, from the presence of an alkaloid—*digitalia.*

Symptoms.—Nausea, vomiting, purging, and severe abdominal pains are first noticed. The patient then complains of pain in the head, giddiness, and a gradual loss of sight. The pupil is dilated, and insensible to light; the pulse weak, slow (40 in a minute) and jerky, sometimes intermittent. The surface of the body is cold, and bathed in perspiration. An aggravation in the symptoms takes place whenever the patient attempts to leave the recumbent position. A marked depression in the action of the heart is a characteristic effect of this poison. Salivation has occurred in some cases on record. Convul-

sions have sometimes been noticed, and syncope and stupor are not uncommon.

Post-mortem Appearances.—Congestion of the brain and its membranes, and some inflammatory redness of the mucous membrane of the stomach. The blood is fluid.

Fatal Dose.—Uncertain. Large doses of the infusion and tincture have been given without any untoward results.

Treatment.—Purgatives and emetics should be given, followed by infusions containing tannin, green tea, oak bark, galls, and strong coffee.

Digitalia.—The alkaloid found in the foxglove.

Tests.—

1. An almost amorphous white, inodorous substance.
2. Almost insoluble in water.
3. Decomposes nitric acid, with the evolution of nitrous acid fumes. An orange-yellow coloured solution is formed, which in a few days assumes a golden-yellow tint.
4. At first, blackened by sulphuric acid, the solution becomes brownish black, red-brown, and lastly, rich crimson colour.
5. Hydrochloric acid with it, at first forms a yellow solution, which then changes to a bright green colour.

TOBACCO.

Nicotiana Tabaccum. Nat. Ord. Solanaceæ.

The consumption of tobacco has greatly increased of late years. In some countries its use was prohibited by stringent laws. In Russia amputation of the nose was the punishment. Several Popes have excommunicated those who smoked in St. Peter's at Rome; and in some parts of Switzerland it was

ranked on the tables next to adultery. Amurath IV. made smoking tobacco a capital offence. Be this as it may, the moderate use of tobacco does not appear to lead to injurious results; and it is found that workmen engaged in the manufactories of tobacco do not suffer from any diseases other than those affecting the generality of mankind.

Nicotia—the alkaloid—is a colourless or slightly amber-coloured, oily, volatile liquid. It is to this principle that the poisonous activity of the drug is due. It differs from the other oily alkaloid *conia*, in appearing of a green colour when a drop is placed on the surface of white enamelled glass, *conia* having a *pink* colour. They both leave a greasy stain on paper. *Nicotia* has been detected by Stass' process in the tongue, stomach, lungs, and liver.

Symptoms.—Symptoms of poisoning by tobacco are by no means uniform, and have been variously described by observers. As a type of the effects produced, the following may be noticed as occurring to the tyro after his first or second 'pipe.' The pulse is primarily quickened, then follow nausea and faintness, accompanied with an intense feeling of sinking. The face is blanched, the pulse slow, perspiration stands on the forehead, and ultimately he vomits and then gradually recovers. Cold air blowing on the face, or sponging the face with cold water, materially hastens a return to comfort. Sometimes, as in the case of a man related by Dr. Marshall Hall, who smoked two 'pipes,' nausea, vomiting, and syncope occurred, followed by stupor, stertorous breathing, general spasms, and insensibility of the pupil. After an interval of a few hours the above symptoms again returned, but from which the patient ultimately recovered. Death has resulted as a sequence to excessive smoking. Gruelin records two cases; one from seventeen, the other from eighteen pipes smoked at a sitting.

The filthy habit of snuff-taking has also been accredited with one or two deaths.

Santeuil, the French poet, died in two days from the effects of snuff mixed with his wine, as a practical joke.

In *animals* the symptoms are nausea, vomiting, purging, convulsions, stupor, and death. The heart becomes paralysed. One drop of the empyreumatic oil on the tongue of a cat killed it in two minutes, the animal dying in convulsions.

Post-mortem Appearances.—These are by no means uniform or characteristic. If much vomiting precedes death, the vessels of the brain may be engorged with blood. Inflammation of the stomach and intestines is also present in some cases.

Fatal Period.—The symptoms soon make their appearance, and death has occurred in three-quarters of an hour, or even less.

Fatal Dose.—Half a drachm.

As an enema, tobacco should be used with extreme care.

Treatment.—Promote vomiting, cold water douches, and stimulants.

LOBELIA.

Lobelia inflata. Nat. Ord. Lobeliaceæ.

Lobelia, or Indian tobacco, is extensively employed in North America in the treatment of asthma. The plant is officinal in the British Pharmacopœia, of which there are two preparations, a simple and an ethereal tincture. In small doses, it possesses expectorant properties.

Symptoms. — Nausea, vomiting, giddiness, cold clammy sweats, and great depression. The pulse becomes irregular, and very feeble. Taken together, the symptoms are not unlike those produced by tobacco.

Fatal Period.—One to two days or more.

Fatal Dose.—One drachm of the powder.

Treatment. — The same as recommended under tobacco.

CEREBRAL.

HYDROCIANIC ACID.

Deaths by hydrocyanic acid are more numerous than those occasioned by any other poison, except opium and its preparations. Hydrocyanic acid is a compound of cyanogen and hydrogen. It was first obtained by Scheele in 1782, but it was not till 1815 that Gay-Lussac pointed out its real nature. Anhydrous hydrocyanic acid may be obtained by passing over cyanide of mercury, gently heated, a stream of dry sulphuretted hydrogen. It is now made by mixing ferrocyanide of potassium with dilute sulphuric acid, and applying heat, when the acid is distilled over, and collected in a cooled receiver.

Dilute hydrocyanic acid, the only important form of the acid in a toxicological point, is a colourless, feebly acid liquid, with a peculiar odour like that of bitter almonds or peach kernels. Sp. gr. 0·997. The pharmacopœial acid contains about two per cent. of anhydrous acid, that of Scheele about four per cent. According to Taylor, however, the percentage of the acid varies from 1·3 to 6·5 per cent. Taking into consideration the smallness of the dose and the shortness of the time before death occurs, it is the most deadly of all known poisons. Prussic acid is not regarded as a cumulative poison; that is, it does not gradually accumulate in the body and then break out with dangerous or fatal violence.

Symptoms.—These will be more or less modified by the quantity of the dose. In most cases they are seldom delayed beyond *one* or *two minutes;* and if the

dose be large, the symptoms of poisoning may come on while the person is drinking. Giddiness, followed by almost complete insensibility, mark the accession of the symptoms. The eyes are fixed, staring, and glassy; the pupils are dilated, and insensible to light. The muscles of the extremities are relaxed, and the limbs flaccid. A white or bloody froth surrounds the mouth, and the jaw is fixed. The surface of the body is cold and clammy to the touch, and the respiration is sometimes long drawn and spasmodic. The pulse so reduced as to be almost imperceptible. The breathing is sometimes *stertorous* in character. This is an important fact; for in ignorance of the occasional presence of this symptom, it was argued that Walter Palmer, whose breathing was stertorous, died of apoplexy, and not from prussic acid, as was alleged. When the dose is small—between twenty and thirty drops of the dilute acid—the patient complains of nausea, giddiness, and a feeling of constriction round the head. The mind is confused, the pulse hurried, and the breathing irregular. Salivation may also be present. Tetanic spasms and involuntary evacuations precede the fatal termination. In most cases where the dose is very large, death takes place suddenly, without convulsions.

External Application.—Applied to the unbroken skin, prussic acid does not appear to have caused any alarming symptoms; but it should be used with the utmost caution where the skin is at all abraded or ulcerated.

Post-mortem Appearances.—In making an inspection, care should be taken; for if the dose be large, the vapour from the corpse on opening it has been known to produce giddiness and fainting. Externally, the skin is pale, livid, or of a violet colour. The hands are clenched, and the nails blue. The jaws are firmly set, and there is usually some froth round the mouth. The internal organs are greatly congested, and the

venous system gorged with fluid dark-coloured blood. The stomach and intestines are sometimes inflamed, but in many cases they present no material alteration in colour.

The appearances when only a small dose has been taken are not unlike those of asphyxia. The detection of the odour of hydrocyanic acid in the body is of importance; but this may be absent from the following causes:—

a. Smallness of the quantity of the acid present.

b. Volatilization from exposure of the corpse to the air.

c. The smallness of the dose, and its absence, the result of absorption and elimination, if death has not rapidly taken place.

d. The amount of dilution of the poison.

e. Concealed by other odorous substances.

In some cases the smell may be detected in the stomach seven or eight days after death. The viscera should, in all cases of suspected poisoning, be placed in a glass stoppered jar, the stopper covered by bladder and tin foil. Hydrocyanic acid is so volatile that, unless the greatest care be taken, all traces of it may vanish, and the guilty allowed to escape.

Fatal Period. — From a few seconds to many minutes. Under active treatment, if a patient survive forty minutes, he will generally recover.

Fatal Dose.—About forty-five minims of the dilute acid of the Pharmacopœia. Recovery has, however, taken place after comparatively large doses. The strength and age of the individual, and also the emptiness or fulness of the stomach at the time the poison is swallowed, will materially affect the issue.

Experiments on Animals.

Numerous experiments on animals have been made to ascertain the rapidity with which prussic acid kills.

Sir R. Christison found that three drops projected into the eye acted on a cat in twenty seconds, and killed it in twenty more; and the same quantity dropped on a fresh wound in the loins acted in forty-five and proved fatal in one hundred and five seconds. In the cases where death did not occur so rapidly, there were regular fits of violent tetanus; but in the very rapid cases, the animals perished just as the fit was ushered in, with retraction of the head. In rabbits opisthotonos, in cats emprosthotonos, were the chief tetanic symptoms.

As a proof that the acid acts equally on the brain and spinal cord, may be noticed the presence of coma and tetanus in some cases of poisoning by this substance.

In the experiments on animals certain effects were noticed, which are as follow :—

Expulsion of the Fæces and Urine.—In some cases only the fæces, in others the urine, alone was involuntarily expelled; and in some other cases neither the one nor the other was present.

The Shriek or Cry.—This cry, though a common, is by no means a constant symptom.

Convulsions.—These are sometimes present.

Acts of Volition.—Only slight acts are possible; in the case of one of the dogs experimented on by Mr. Nunneley, the animal 'went down, came up, and then went down again the whole flight of a steep, winding staircase.'

The *post-mortem appearances* were not well marked in the animals subjected to experiment. In chronic cases Mr. Nunneley states that both sides of the heart were distended with black blood. The pure acid is stated to completely destroy the irritability of the heart and voluntary muscles, galvanism producing no effect whatever. 'In eight experiments on cats and rabbits with the pure acid, the heart contracted spontaneously, as well as under stimuli, for some time

after death, except in the instance of the rabbit killed with twenty-five grains, and one of the cats killed by three drops applied to the tongue. In the last two the pulsation of the heart ceased with the short fit of tetanus which preceded death; and in the rabbit, whose chest was laid open instantly after death, the heart was gorged, and its irritability utterly extinct.'[1]

Treatment.—The treatment of poisoning by prussic acid has now to be considered.

Ammonia.—The use of this substance was first advocated by Mr. John Murray of London, and is no doubt a valuable remedy if given early. Care should be taken that the mucous membrane of the air passages and alimentary canal be not inflamed by using too strong a solution.

Chlorine.—Recommended by Riauz in 1822. Water impregnated with the vapour of chlorine may be given internally, and the gas may be breathed under proper precautions.

Cold Affusion.—First proposed by Dr. Herbst of Göttingen. Its success is most to be looked for when it is employed before the convulsive stage of the poisoning is over. The cold water should be poured on the head and down the spine.

Bleeding from the Jugular Vein.—In one case treated by Magendie, bleeding from the jugular vein was attended with success.

Chemical Antidotes.—The administration of a solution of carbonate of potash, followed by a solution of the mixed sulphates of iron, has been suggested. The formation of Prussian blue is the result. The only objection to this treatment is, that prussic is so rapidly absorbed, that death may result from the already absorbed acid before the antidote can be given.

Detection of Hydrocyanic Acid in cases of Poisoning.

The 'vapour tests' are those most readily applied

[1] Christison *On Poisons*, p. 759.

to organic mixtures; but in some cases it may be necessary to make a distillation of the suspected substance, in order to isolate the poison.

The first point to be noticed is, whether any *odour* of the acid can be perceived in the substance under examination. In any case the contents of the stomach or finely divided tissues should be mixed with water and examined as to the reaction with test paper. If the mixture is found to be *alkaline*, it must be neutralized by the addition of tartaric acid; if, on the contrary, it be *acid*, carbonate of soda must be carefully added to neutralization. A state of neutrality is always necessary previous to distillation for the following reasons:—

An *alkaline* state of the liquid would on the one hand prevent, or at all events retard, the evolution of the hydrocyanic present; whilst on the other, the presence of *any free acid* would decompose any cyanide which might be present, and thus give rise to an evolution of hydrocyanic acid not present as such in the mixture.

The organic mixture is then placed in a flask, and the contents distilled at as low a temperature as possible by the aid of a water bath.

Should hydrocyanic be present, the distillate will yield all the characteristic reactions of the dilute acid. Nitrate of silver will give a curdy white precipitate, with, on the addition of some hydrochloric acid and sulphate of iron, the formation of Prussian blue. In this test, which may be taken as quite conclusive, the hydrochloric acid decomposes the cyanide of silver, and on the addition of the sulphate of iron Prussian blue is formed.

If a portion of the dry precipitate formed by the nitrate of silver be heated in a test tube, cyanogen gas will be evolved, known by its characteristic odour of peach-blossoms, and by its burning with a rose-coloured flame.

Vapour Tests.

There are three tests for the presence of hydrocyanic acid when present in organic mixtures, which have the advantage of being applicable without the addition of anything extraneous to the mixture to be tested. They are all dependent on the volatile nature of hydrocyanic acid, and may be applied as follow, the suspected mixture being divided into three portions :—

1. The liquid mixture to be tested is placed in a small beaker glass, and covered with a glass plate, the centre of which is smeared with a mixture of potash and proto-sulphate of iron. The whole is now left undisturbed for some time. The glass is eventually removed, and the mixture of potash and iron treated with hydrochloric acid, which, should hydrocyanic acid have been present, will cause the development of Prussian blue.

2. A second portion of the original mixture is placed in a beaker, and a watch-glass containing a few drops of bisulphide of ammonia is suspended over the liquid, the mouth of the beaker being closed. A short time is allowed to elapse; the watch-glass is then removed, and its contents evaporated to dryness at a low temperature. A blood-red colour is developed on the addition of a little perchloride of iron to the dry residue. This effect is due to the absorption of the hydrocyanic acid vapour by the bisulphide of ammonium—sulphocyanide of ammonium being formed, which, on the addition of perchloride of iron, gives the blood-red colour of the sulphocyanide of iron.

3. If a watch-glass containing a few drops of nitrate of silver solution be suspended in a beaker as in '2,' the silver solution will become white and opaque, from the formation of cyanide of silver. This mixture, treated with hydrochloric acid and sulphate of iron, will give Prussian blue.

The following plants contain prussic acid, and are

therefore more or less poisonous in proportion to the quantity of the acid which they severally contain :—

Nat. Ord. Rosaceæ.

Sub. Ord. Amygdaleæ, or Drupaceæ.

Amygdalus communis. — The almond and its varieties.

Prunus domestica.—The plum and its varieties.

Cerasus.—The cherry and its varieties.

Pyrus aria, or white bean tree.—The seeds are poisonous.

Nat. Ord. Euphorbiaceæ.

Jatropha manihot, or bitter cassava.

BITTER ALMONDS.

The essential oil of bitter almonds is very poisonous. 'The oil does not, like common essential oils, exist ready formed in the almond; but it is only produced when the almond pulp comes in contact with water. It cannot be separated by any process whatever from the almond without the co-operation of water—neither, for example, by pressing out the fixed oil, nor by the action of ether, nor by the action of absolute alcohol. After the almond is exhausted by ether, the remaining pulp gives the essential oil as soon as it is moistened; but if it is also exhausted by alcohol, the essential oil is entirely lost. The reason is, that alcohol dissolves out a peculiar crystalline principle named Amygdalin, which, with the co-operation of water, forms the essential oil by reacting on a variety of the albuminous principle in the almond, called Emulsin, or Synaptase.'

The essential oil of bitter almonds may contain from 6·0 to 14·33 per cent. of hydrocyanic acid. Deaths from the incautious use of this oil for flavouring articles of confectionery are not infrequent. As

the flavour is not in the least injured, it has been suggested to subject the oil to repeated distillation with caustic potassa, by which means the oil is purified from prussic acid.

Symptoms.

IN MAN.	IN ANIMALS.
Nausea, vomiting, and diarrhœa, due to gastric irritation, have occurred when the dose has been small, as is the case when confectionery owes its flavour to the use of the essential oil. Idiosyncrasy may have something to do with these effects, for cases are on record where a single almond has produced a state resembling intoxication, followed by an eruption not unlike urticaria or nettle-rash. Taken in large doses, the symptoms produced are identical with those described under poisoning by prussic acid. The breath is usually strongly impregnated with the odour of bitter almonds.	Vomiting, trembling, weakness, paralysis, tetanic convulsions, and coma.

Post-mortem Appearances.—These are identical with those seen in poisoning by the pure acid.

Fatal Dose.—The essential oil is from four to eight times as strong as the acid of the Pharmacopœia. From twenty to thirty drops have proved fatal.

Death may take place in half an hour or less.

Treatment.—The same as recommended under prussic acid.

THE CHERRY-LAUREL.

The Cherry-Laurel, — *Prunus Lauro-cerasus,* — the leaves of which have been used for flavouring custards, etc., contain prussic acid, and are therefore poisonous.

In the British Pharmacopœia there is an *Aqua Lauro-cerasi*—laurel water—prepared from the leaves. It should be used with extreme caution, as the amount

of hydrocyanic acid contained in the leaves is uncertain. Death has frequently resulted from its use. The most important case, however, is that of Sir J. Broughton. 'His mother, who gave him his usual draught on the morning of his death, noticed that it had a strong smell of bitter almonds. Two minutes after he took it she observed a rattling or gurgling in his stomach; in ten minutes more he seemed inclined to dose; and five minutes afterwards she found him quite insensible, with the eyes fixed upwards, the teeth locked, froth running out of his mouth, and a great heaving at his stomach and gurgling in his throat. He died within half an hour after swallowing the draught.' No light was thrown on the case by the carelessly conducted *post-mortem;* but the suddenness of his death, the improbability of apoplexy occurring at so early an age, and the odour of bitter almonds noticed by his mother, pointed out clearly enough the true cause of death.

OXALIC ACID

is a powerful poison, but on account of its strongly acid taste it is ill-adapted for the purposes of the murderer. Deaths have not infrequently followed the accidental substitution of this substance for Epsom salts,—sulphate of magnesia,—which it somewhat closely resembles. The ordinary crystals of oxalic acid are in the form of four-sided prisms, colourless, transparent, odourless, or with a slight acid smell, very acid taste, and not deliquescent in the air.

It is largely used in the arts by brass polishers, straw-bonnet makers, bookbinders, and others.

Symptoms.—These present many strange anomalies. Death may occur so rapidly as to prevent any attempt at treatment. When the dose is large, an acid taste is experienced during swallowing, followed by burn-

ing pain in the throat and stomach. Vomiting then sets in, and in most cases continues till death, which may, however, occur when this symptom has existed from the first. The vomited matters may be simply mucus, mucus and blood, or dark coffee-grounds-looking matter. Unless the case is protracted, the bowels are rarely much affected, though purging and tenesmus have been noticed.

Collapse now sets in; the pulse becomes feeble and scarcely perceptible, the skin cold and clammy. Should the treatment adopted prove successful, and life be prolonged, the patient complains of tenderness of the mouth, soreness of the throat, and painful deglutition. Pressure over the abdomen causes pain. Vomiting and purging are also frequently present; and if recovery takes place, convalescence is generally very gradual.

Oxalic acid acts as a poison when applied to a wound in any part of the body. Although oxalic acid undoubtedly acts on the brain through the medium of the blood, it is a remarkable fact that *it cannot be detected in that fluid* (Christison). The blood does not appear to undergo any physical change. Unlike the mineral acids, oxalic acid is still poisonous even when its corrosive and irritant properties have been destroyed by dilution.

Post-mortem Appearances.—The mucous membrane of the mouth, tongue, and throat is corrugated, white, and softened. The tongue is sometimes of a brownish colour, and sordes appear on the teeth. The stomach is in some cases pale, soft, and very brittle, and contains a dark, grumous, acid liquid; at other times it presents several semi-gelatinous spots, looking as if they had been boiled. Enlarged blood-vessels filled with dark-coloured blood are also seen ramifying over the internal surface of the organ. Perforation is of rare occurrence. The intestines generally escape with some slight inflammatory redness, unless the

case is unusually prolonged. In some cases the stomach is quite healthy, no morbid appearance being found in any portion of the alimentary canal.

Fatal Dose.—Three drachms have caused death in one hour, and recoveries have been known to take place after an ounce had been swallowed.

Fatal Period.—Death has resulted in *ten minutes* from a dose of *one ounce.* The time varies with individuals even when the same quantity is taken. In the case of two girls who each swallowed *an ounce* of oxalic acid, one died in *ten minutes* and the other in *thirty minutes.*

Treatment.—Water should not be given, as it increases the solubility of the acid, and thus assists in the more extensive absorption and diffusion of the poison. The carbonates of potash and soda should be avoided, as the oxalates of these alkalies *are themselves* poisonous. Lime is the best antidote, as the oxalate of lime is insoluble. Vomiting should be promoted. In the stage of collapse the case must be treated on general principles.

ESSENTIAL SALT OF LEMONS.

The binoxalate of potash or salt of sorrel, or as it is more commonly known as salt of lemons, occurs as a constituent of many plants. The common sorrel—*Rumex acetosa*—contains it in large quantities.

Symptoms.—Those of poisoning by oxalic acid, on which its poisonous properties depend.

Post-mortem Appearances. — Inflammation of the stomach and intestines. Other appearances as in oxalic acid.

Fatal Period.—*Eight minutes* in the case of a lady recently confined, who took half an ounce of the salt by mistake for cream of tartar.

Fatal Dose.—Half an ounce.

Treatment.—The same as recommended for poisoning by oxalic acid.

Table showing Symptoms, Post-mortem Appearances, Fatal Dose and Period, and Treatment of Poisoning.

	SULPHURIC ACID.	HYDROCIANIC ACID.	OXALIC ACID.
Symptoms.	Burning pain in the mouth, throat, and gullet. Constant vomiting of brownish or blackish matter containing blood. The lips shrivelled, blistered, and excoriated; and the corners of the mouth show signs of the corrosive action of the poison. Collapse and death.	Giddiness, insensibility, difficult respiration, dilated pupil, tetanic spasms, and convulsions. In acute cases, death by shock; in those more prolonged, suffocation ends the scene.	Burning pain in the mouth and throat, vomiting of greenish-brown or grumous matter. Collapse sets in; skin cold and clammy, frequent pulse, and respiration hurried. Delirium and convulsions end in death. Effects depend on size of dose. Well diluted, it acts on brain, spine, and heart.
Post-mortem Appearances.	Presence of the signs of powerful corrosion, perforation of the stomach, which is blackened and softened.	Face pale and countenance composed, congestion of the brain, and traces of inflammation in the stomach and bowels. Odour of prussic acid may be detected in most cases in the stomach and other parts of the body.	Lining membrane of mouth and fauces white, shrivelled, and easily removed. Perforation of stomach rare. *Post-mortem* appearances depend on dilution of acid.

Fatal dose.	One drachm.	About 45 minims of the Pharmacopœia acid.	One drachm in a boy, in another case half an ounce.
Fatal Period.	One hour. Average about ten hours.	Two to five minutes.	Less than ten minutes.
Treatment.	Magnesia, chalk whiting, soap suds, milk, and mucilaginous drinks.	Chlorine in vapour and in water, and the mixed oxides of iron. Cold affusion to the head and face, galvanism, artificial respiration, etc.	Chalk and water. Promote vomiting. Magnesia, lime water, and oil. Mucilaginous drinks.

NEURAL.

ACONITE.

Aconitum Napellus. Nat. Ord. Ranunculaceæ.

All parts of this plant are poisonous. The poisonous properties depend upon the presence of an alkaloid —*aconitia*—chiefly found in the root. When any part of the plant is chewed, a sensation of tingling is experienced in the mouth and burning in the throat. Many of the aconites are, however, inert. The root having been taken by mistake for horseradish, has led to several cases of accidental poisoning.

ACONITE.	HORSERADISH.
General Characteristics. — Root conical, dark-brown externally, with numerous twisted rootlets; internally the colour is whitish.	*General Characteristics.* — Root cylindrical, of nearly the same thickness down its whole length. Externally, buff coloured; internally, white.
Taste.—Produces a tingling and numbing sensation in the mouth.	*Taste.*—Sweet and pungent.

Symptoms.

IN MAN.	IN ANIMALS.
The patient complains, within a short time after the poison is taken, of dryness of the throat, accompanied with tingling and numbness of the mouth and tongue. He then complains of nausea, vomiting, and pain in the epigastrium; of a sensation of formication or tingling, with numbness in his face and limbs, which appear to him heavy and enlarged. In attempting to walk he staggers, his limbs losing their power of supporting his body. He becomes giddy, and his sight and hearing imperfect, but he is seldom unconscious. His pulse irregular, gradually becomes weaker, his skin cold and clammy, his features pale and bloodless, his mind clear, and then suddenly he dies, in some cases from shock, in others from asphyxia, and lastly he may die from syncope.	Weakness of the limbs and staggering, the respiration slow and laboured, loss of sensation, paralysis, dimness of vision, increasing difficulty in breathing, *convulsions*, and death by *asphyxia*.

Post-mortem Appearances.—General venous congestion. The brain and its membranes are in most cases found congested, and the stomach and intestines inflamed.

Fatal Period.—The symptoms may come on immediately, or may be delayed for an hour or two. An excise officer, who died in about four hours, was able to walk from the Custom House over London Bridge. Death has taken place in so short a time as one hour and a quarter.

Fatal Dose.—About four grains of the extract, and one drachm of the tincture. Much will depend upon the amount of the alkaloid present. One drachm of the scraped root is said to have proved fatal.

Treatment.—Emetics, castor oil, and animal charcoal should be given. Stimulants will be required; and friction down the spine, together with galvanism and artificial respiration, may be tried.

Synopsis of Poisoning by Aconite.

1. Symptoms—

a. In Nervous System.—Giddiness, numbness, and tingling in the limbs is a primarily effect, followed by gradually increasing paralysis of the muscles and insensibility of the surface of the body to pinching and pricking. Dr. Fleming asserts that it produces a *powerful sedative effect on the nervous system.*

b. In Vascular System.—Extreme depression of the circulation is produced by doses large enough to cause death.

c. In Digestive System.—Some have denied the irritant action of aconite on the alimentary canal, but Sir R. Christison states that he was deterred from the use of aconite 'by two patients being attacked with severe vomiting, griping, and diarrhœa.'

CONIUM.

Conium maculatum. Nat. Ord. Umbelliferæ.

The common or spotted hemlock is indigenous. It must be distinguished from the *myrrhis temulenta*, another indigenous, umbelliferous plant which has also a spotted stem, but which is covered with hairs, the stem of the hemlock being smooth. Several cases of poisoning have occurred, hemlock having been mistaken for parsley, fennel, asparagus, and parsnip.

The leaves of the plant have a peculiar mousy odour, which is intensified when they are rubbed in a mortar with some caustic potash.

The poisonous properties reside in an alkaloid, *conia*.

The activity of the plant appears to depend upon the time of the year when it is gathered, being most powerful in May. The ready decomposition of the alkaloid by heat or age renders the extract of conium a very uncertain preparation, the conia being converted into an inert resinoid matter.

CONIA

is a colourless volatile oil, lighter than water, with an odour of mice. It is strongly alkaline, soluble in diluted acids, but its salts have not yet been crystallized. It is a deadly poison, killing all animals, death resulting from asphyxia. Neutralized with an acid, its activity is increased, and it becomes more soluble in water. Almost instant death in a dog resulted from injecting two grains of conia, neutralized with hydrochloric acid, into the femoral vein.

The symptoms and *post-mortem* appearances are the same as mentioned under conium.

Symptoms.

IN MAN.	IN ANIMALS.
The symptoms in some cases resemble those of poisoning with opium; in others the patient complains of dryness and constriction of the throat, and drowsiness. There is dilatation of the pupil and loss of power in the muscles of the extremities. Gradual loss of power in the respiratory muscles is the cause of death. Giddiness, coma, and convulsions were the typical symptoms of two cases of accidental poisoning recorded by Dr. Watson.	'Palsy, first of the voluntary muscles, next of the chest, lastly of the diaphragm, — asphyxia, in short, from paralysis, without insensibility, and with slight occasional twitches only of the limbs; and the heart was always found contracting vigorously for a long time after death.'—CHRISTISON.

Post-mortem Appearances.—Congestion of the vessels of the brain and lungs. The blood is very fluid, and of a dark colour, the fluidity due probably to the mode of death — slowly induced asphyxia. There may be some redness of the mucous membrane of the alimentary canal.

Fatal Period.—The symptoms may come on in from ten minutes to an hour or more after the poison has been taken. Death usually takes place in about four hours.

Fatal Dose.—Uncertain. Thirty grains of the extract carefully prepared killed a rabbit in five minutes. A single drop of conia dropped into the eye of a rabbit killed it in nine minutes.

Treatment. — Emetics, castor oil, followed by ammonia and other diffusible stimulants.

CALABAR BEAN.

Physostigma Venenosum. Nat. Ord. Leguminosæ.

A strong emulsion of this bean is used on the western coast of Africa as a test of innocence in cases

of suspected witchcraft. In 1864 some children in Liverpool were poisoned by eating some of these beans, which had been swept out of a ship from Africa on to a heap of rubbish.

Symptoms.—Vomiting, giddiness, irregular action of the heart; the mental faculties are unaffected. The eyes are bright and the pupils *contracted;* in which latter it differs most strikingly from atropia, hyoscyamia, and datura, where dilatation of the pupil is the rule. Sir R. Christison considers that its primary action is on the heart, causing paralysis of that organ, and that the insensibility and coma are only secondary. Dr. Harley considers that it is not a cardiac, but a respiratory poison. The motor nerves appear to be affected, the intellect being left clear. A few drops of the extract placed in the eye causes powerful contraction of the pupil.

The Analysis.—The physiological test is the effect on the pupil. Bromine dissolved in water is stated by Dragendorff to produce a red colour with the calabar bean.

EXCITOMOTORY.

Nux Vomica. Strychnia.

Some of the most poisonous known plants belong to the genus Strychnos. *Nat. Ord. Loganiaceæ.*

The Java poison *Upas Tieuté* is a watery extract of S. Tieuté; the basis of the poison used in Guiana, and known as Wourali, Ourari, Urari, or Curare, is the juice of S. Toxifera. S. Nux Vomica, the Koochla tree, produces the Nux Vomica seeds of commerce; and the bark of the tree has been accidentally substituted for cusparia, or angustura bark, hence it is known as *false angustura* bark. The substitution is attended with considerable risk, on account of the

strychnia which the false bark contains. It may be known by its being quilled, externally covered with white lichenous spots; and the internal surface becomes *blood-red* when touched with nitric acid. This reaction, which depends upon the presence of an alkaloid, Brucia, *does not* occur when true angustura bark is thus treated.

NUX VOMICA.

The seeds of S. Nux Vomica.

The British. Pharmacopœia contains an extract and a tincture. Strychnia is also obtained from the seeds.

The active principle of the seeds is the alkaloid strychnia.

The symptoms and *post-mortem* appearances will be detailed under the head of Strychnia. The brown powder of the seeds may, in some cases, be seen adhering to the mucous membrane of the stomach.

Treatment.—As for strychnia.

STRYCHNIA.

Symptoms.—Should the poison be in solution, the patient complains of a hot and intensely bitter taste during swallowing. The effects of the poison become manifest in from a few minutes to an hour or more after it is taken. The earliest symptoms are a feeling of suffocation and great difficulty of breathing. These come on suddenly, without any premonitory warnings. Twitchings of the muscles, rapidly passing into tetanic convulsions of nearly all the muscles of the body, which are simultaneously affected. The head after several jerks becomes stiffened; the body curved forward, quite stiff, and resting on the back of the head and heels. The face is congested, and the coun-

tenance expresses intense anxiety, the eyes staring, the mouth open, and the lips livid. The throat is dry, the thirst great; but when an attempt is made to drink, the jaws are spasmodically closed, and a piece of the vessel may be bitten out. During the intervals of the paroxysms, the intellect is usually clear, and the patient appears conscious of his danger, frequently exclaiming, 'I shall die!' and he is also conscious of the accession of the paroxysms, telling those around him of their approach, and asking to be held. In the case of J. P. Cook, poisoned by Palmer, those about him tried to raise him; but he was so stiff, that they found it impossible. He then said, 'Turn me over,' which they did, and he died in a few minutes. Intense pain is felt, due to the powerful contractions of the muscles. After the lapse of a minute or two, the spasms subside, a sudden lull takes place, during which the patient feels exhausted and his skin bathed in sweat. In poisoning by strychnia, the jaws are slightly, if at all, affected. In tetanus the result of disease, the locking of the jaws is an early and a marked symptom.

As death approaches the fits become more frequent, and the patient dies from exhaustion or suffocation. The poison may fail to be detected, and this link in the scientific evidence may be wanting, as was the case in Palmer's trial; whereas the strychnia had been administered in *pills*, and after death the stomach had been cut open, and the contents lost; there was little hope of discovering the poison. The non-discovery of the poison was made a strong point on the part of the defence, ignoring at the same time the fact that the stomach had been tampered with and the contents spilt. Death may be the direct result of a dose of strychnia, and yet it may not be detected in the dead body, even with the greatest care, and when the body has not been tampered with.

Post-mortem Appearances.—There is no characteristic

appearance found after death. The blood is fluid, the heart empty, with some congestion of the membranes of the brain. Absence of all cause for so violent and sudden a death. *Rigor mortis* is prolonged for some time.

Fatal Period.—The rapidity in the accession of the symptoms and fatal termination will, to some extent, depend upon the form in which the poison is taken, *i.e.* in solution or in pill. In most cases the symptoms appear in from three or four minutes to an hour or more after the poison is swallowed, death following in from ten minutes to six hours.

Fatal Dose.—A quarter to half a grain; but large doses have been taken followed by recovery.

Treatment.—Evacuation of stomach by emetics and stomach pump, and then the administration of animal charcoal, iodide of potash, tannic acid, and tea, followed by diffusible stimulants.

Analysis.—The alkaloid abstracted from the tissues or contents of the stomach by Stass' process may have the following tests applied to it:—

1. Scarcely soluble in water, but readily soluble in acidulated water.
2. Intensely bitter taste.
3. Not affected by sulphuric acid; but when a little peroxide of lead, or peroxide of manganese, or bichromate of potash, or ferridcyanide or permanganate of potassium is added, a magnificent purple-blue colour changing to crimson, and finally to a light red tint. Less than $\frac{1}{100,000}$ of strychnia has been stated to give this reaction. The physiological test consists in introducing a small quantity of the suspected substance under the skin of a frog, and noting whether the animal suffers from tetanic spasms or not.

The following Table will assist in forming a Diagnosis of Death by Strychnia, and that the Result of Disease.

TETANUS FROM EXPOSURE TO COLD AND WET, OR THE RESULT OF A WOUND.	TETANUS FROM STRYCHNIA.	HYSTERIA.	EPILEPSY.	TETANUS OCCURRING DURING THE ACTION OF OTHER POISONS.
1. Presence of wound. Symptoms have no connection with any liquid or solid swallowed.	1. Some solid or liquid taken within a short time of the commencement of symptoms.	1. Connected with a peculiar constitution. Rare in males.	1. Previous history of epilepsy.	1. Presence of other symptoms of poisoning peculiar to certain poisons.
2. Gradual accession and progress of the symptoms; difficulty in swallowing; stiffness of the jaws, neck, trunk, legs, and arms. Hands not generally affected.	2. Symptoms sudden and violent. All the muscles are affected at one and the same time. Arms affected, and hands clenched at same time as the body and legs. Jaw not	2. Presence of known signs of hysteria.	2. Presence of the *aura epileptica*. Tongue bitten; insensibility lasting for some time.	*Obs.*—Arsenic, antimony, and other irritant poisons may sometimes

	affected or fixed, only during efforts to swallow.			cause tetanic spasms; but other symptoms are present which point to the nature of the poison.
3. Curving of the spine forwards not primarily present; generally comes on after some days of previous illness.	3. An early symptom, generally appearing in a few minutes.	3. Spasms frequently convulsive, alternating with stiffness of the muscles. Loss of consciousness.	3. Alternate contraction and relaxation of the muscles.	
4. Symptoms may undergo abatement, but there is no perfect intermission.	4. Intervals of complete intermission.	...	...	...
5. Death after the lapse of several hours or days. Direct injury to spinal cord may give rise to tetanus and death in a few hours. Recovery slow.	5. Death usually occurs in three hours, or even less than a quarter of an hour. Recovery in a few hours.	5. Never fatal. Recovery very rapid.	5. Seldom fatal during first attack.	...

IRRESPIRABLE GASES.

CARBONIC ACID.

Poisoning by Carbonic Acid.

1. *Circumstances which may show that it is Suicidal.*—The position of the body and the presence of one or more of the methods adopted for the generation of the gas. But it must always be borne in mind, that in order to conceal a murder, the body may be placed under circumstances which point to carbonic acid poisoning. Poisoning by this gas is a favourite mode of suicide in Paris.

2. *Circumstances under which it occurs Accidentally.*—Death may result where several persons are sleeping in the same room, and the ventilation is imperfect; from the admission of the vapour of charcoal into a room from an adjoining vent; or from incautiously sleeping in a brewery close to a vat in which fermentation is going on.

3. *Symptoms.*—The early symptoms are a feeling of weight and fulness in the head, accompanied with giddiness, throbbing of the temporal arteries, drowsiness, palpitation of the heart, gradually increasing insensibility, stertorous breathing, ending in death from asphyxia or apoplexy. Sometimes the victim dies convulsed, at other times a deep sleep quietly merges into death. The symptoms will of course depend upon the quantity and purity of the gas present in the apartment.

4. *Post-mortem Appearances.*—The face may be pale and composed, or swollen and livid. The vessels of the brain are frequently greatly congested, and the heart and great vessels gorged with black fluid blood. The blood in some cases is, however, of a cherry red

colour. The tongue may or may not be protruded beyond the teeth; in most instances the latter is the case. Animal heat is long retained after death, and the *rigor mortis* occurs as in other forms of death.

5. *Treatment.*—Bleeding from the arm, cupping from the nape of the neck, and the employment of cold affusion to the head. The patient should be removed without delay into the open air. Artificial respiration and galvanism have been successfully employed in some cases.

6. *How proportion of Carbonic Acid may be estimated.*—The air to be examined is drawn into a vessel capable of holding one and a half gallons, to which is added a clear solution of lime or baryta. The vessel, after being well agitated, is allowed to remain untouched for from eight to twenty-four hours. The carbonic acid is absorbed by the lime or baryta, and the difference in the causticity of the lime solution before and after it is placed in the vessel gives the amount of carbonic acid present in the air.

7. *How may a Well or Mine be cleared of it?*—In the case of a well, a basket of slacked lime may be let down; but in mines, a steam fanner or a jet of steam must be blown through the mine. No one, of course, should be allowed to enter the well or mine till it has been cleared of the carbonic acid.

CARBONIC OXIDE.

This gas is formed in a variety of ways, one being the oxidation of carbon at a very high temperature in a limited supply of oxygen. It is a very powerful gas, speedily causing death by acting chiefly on the nervous system. To this gas is due the suffocating quality of air in which coke or charcoal is burnt.

SULPHURETTED HYDROGEN.

Sulphuretted hydrogen is a gas possessing a powerful odour of rotten eggs. It is largely used as a test for most of the metals; and its presence may be detected by filtering paper moistened with a salt of lead becoming black.

The symptoms produced when the gas is moderately diluted are giddiness, throbbing of the temples, pain and oppression in the stomach, nausea, and vomiting. Delirium and convulsions sometimes occur, together with laborious respiration and an irregular pulse. When the gas is but slightly diluted, the person becomes suddenly weak and insensible, and rapidly dies. The *post-mortem* appearances are fluidity and blackness of the blood, loss of muscular contractility, and a tendency to rapid putrefaction. The bronchial tubes are reddened, and the internal vascular organs may appear almost black.

The treatment will consist in the immediate removal of the person into fresh air, and the administration of stimulants, together with the respiration of chlorine gas evolved from bleaching powder by the action of an acid.

TOXICOHÆMIA.

Under this head may be classed all those effects produced by the sting or bite of various insects and reptiles, and also by the bite of the mad dog and wolf. No medico-legal question is likely to be raised on this subject, at least in this country, where, with the exception of the common viper or adder, all our reptiles are harmless enough.

MEDICAL POLICE.

Man, subject to certain physical and moral influences, should be regarded rather as a species than as an individual.

These influences are—

A. Purely physical or *natural*.

1. Sex. 2. Age. 3. Locality. 4. Periods. 5. Seasons. 6. Hours of the day.

B. Moral or *disturbing*.

By the operation of this second group, man is distinguished from the lower animals.

A. Purely physical.

1. Sex.—More male children die in the earlier years of infancy than female. The male births are in excess of the female, as seen from the following tables.

Table showing the ratio of Boys to Girls in the following Countries.

Countries.	Boys.	Girls.
France	106·55	100
Russia	108·91	,,
Holland and Belgium .	106·44	,,
Sweden	104·62	,,
England	103·5	,,
Average of Europe . .	106·00	,,

Table showing the ratio of Legitimate and Illegitimate Boys to Girls for every 100 *Girls.*

COUNTRIES.	Legitimate.	Illegitimate.
Sweden . . .	104·73	103·12
France . . .	106·69	104·78
Austria . . .	106·15	104·32
Bohemia . . .	105·65	100·44
TOWNS.		
Paris	103·82	103·42
Amsterdam . .	105·00	108·83
Leipzig . . .	106·16	105·94

As already stated, more males die during infancy than females, and this effect of the sexes is well pronounced in all that concerns the deaths. This mortality does not only affect the males before birth, but even during the first ten or twelve months after birth, that is to say, during the period of nursing. The ratio of deaths before birth is as 3 to 2; during the first and second months after birth, as 4 to 3; during the fourth and fifth months, 5 to 4; till between the eighth and ninth the difference between the male and female deaths is almost *nil.* In Belgium, the ratio of male still births to female is as 1·33 to 1 for the towns, and 1·70 to 1 for the country. At birth the mortality is greater in males than in females; but at two years of age the mortality is nearly the same. At the age of puberty the female mortality is in slight excess of the male; between 21 and 26 the male deaths are again in excess of the female; but between 26 and 30 they are equal. During the period of child-bearing the female deaths exceed the male in country places, but this mortality again diminishes

after the catamenia have ceased. It is also found that congenital malformations are more common in the male than in the female, due probably to some intra-uterine forces, the exact nature of which have not yet been determined, but which appear to act after birth. Males are more liable to diseases of the vascular system, calcification, and atheroma of the arteries, angina-pectoris, and also to dangerous hæmorrhages.

2. Age.—The fecundity of marriages appears to be in an inverse ratio to the age of the parents. The fecundity of marriages is greatest when the husband and the wife are about the same age, or in those in which the man is older than the woman by from 1 to 6 years. The number of births is not, however, appreciably affected when the difference in the ages does not exceed 16 years; but the minimum of fecundity is reached when this limit is exceeded, or the man is much younger than the female. Early marriages are generally sterile; or when children are born, the tendency to early death is great. Fruitful marriages produce the same number of births, irrespective of age or locality, provided the age of the man is at or about 33 and that of the woman 26 years. After these ages the number of births gradually diminishes.

The period of greatest fecundity is, therefore, at 33 years of age for the man and 26 for the female. Other things being equal, those marriages are most productive when the age of the man is either slightly under or in excess of the female.

The number of marriages very sensibly diminishes over 40 years of age. The fecundity of women ceases between the ages of 45 and 50; that of men is uncertain.

The effect of the Ages of the Parents on the ratio of Boys to Girls is seen from the following Tables.

Age of the Man.	Age of the Woman.	Boys to 100 Girls.
The man is younger	than the woman.	90·6
,, same age	as ,,	90·0
,, older	3 to 6 years.	103·4
,, ,,	6 to 9 ,,	124·7
,, ,,	9 to 18 ,,	143·7
,, ,,	18 ,, and more.	200·0
The man 24 to 36 years,	the woman 16 to 27 years.	116·6
,, ,, ,,	,, 36 to 46 ,,	95·4
,, 36 to 48 ,,	,, is young.	176·9
,, ,, ,,	,, middle age.	114·3
,, ,, ,,	,, over middle age.	109·2
,, 48 to 60 ,,	,, middle age.	190·0
,, ,, ,,	,, over middle age.	164·3

Difference of Age—the Husband being	Number of Marriages.	Births.		Ratio of Boys to Girls.	Children to each Marriage.
		Boys.	Girls.		
Younger. . .	54	122	141	86·5	4·87
Same age. . .	18	54	57	94·8	6·17
Older. . . .	...	...	...	...	...
From 1 to 6 years.	126	366	353	105·7	5·71
,, 6 to 11 ,,	107	327	258	126·7	5·47
,, 11 to 16 ,,	43	145	97	147·4	5·58
,, 16 and above.	33	95	57	165·2	4·55
Total . .	381	1105	965	114·8	5·43

Age exerts a powerful influence on the mortality, and this influence is universally acknowledged. Out of 100,000 males alive at 3, only 94,417 will probably

be alive at 10; of females at the same age, 94,551. At the age of 50, 59,123 males will be alive, and 65,237 females. Nine females out of 100,000 may reach the age of 100, but none of the other sex.

At the age of 5, the mortality, which had previously been so marked, is suddenly arrested; and it is at this age that the probability of life is greatest. At puberty the maximum of viability is reached; after that period the mortality is greatest, especially among women, when the passions become developed and the dangers of maternity are greatest. Between 60 and 65 the probability of life becomes very doubtful.

The following Table gives the probable Duration of Life of Men and Women in various Countries.

Ages.	France.		England.		Holland.	Sw'den.	Europe.
	Duvillard.	Deparcieux.	Morgan.	Milne.	Kerssboom.	Wargentin.	General Table.
Birth.	20	...	8	41	51	33	38·5
5 years.	46	54	41	57	47	51	53·3
10 „	43	52	40	53	45	49	50·3
15 „	39	48	37	49	41	45	46·0
20 „	36	44	34	45	38	41	42·2
25 „	33	41	31	40	35	37	38·5
30 „	29	37	28	36	32	33	34·5
35 „	26	33	26	33	29	29	30·5
40 „	23	29	23	29	26	25	26·5
45 „	20	25	20	25	23	22	23·2
50 „	17	21	17	21	20	19	19·2
55 „	14	18	15	18	17	15	16·0
60 „	11	14	12	14	14	12	12·7
65 „	8·5	11	9	11	11	9	9·5
70 „	6·5	8	8	8	8	7	7·2
75 „	5	6	6	6	6	5	5·2
80 „	3·5	4	4	4·6	4·5	3·5	3·7

Table showing probable Duration of Male and Female Life in different Countries, and at different Ages.

Ages.	Sweden.		Engl'nd.		B'lgium.		Nether-lands.		Bavaria.		General Mean.	
	Berg.		Farr.		Quetelet.		Baum-hauer.		De Her-man.			
	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.
Birth.	48	55	44	46	40	43	31	36	22	32	37	43
5 years.	54	59	54	56	53	54	51	54	53	53	53	55
10 ,,	50	55	51	52	49	51	49	51	50	49	50	52
15 ,,	45	50	47	48	46	47	44	47	46	45	46	47
20 ,,	41	46	43	44	42	43	40	43	41	41	41	43
25 ,,	37	42	39	40	38	40	37	39	38	37	38	40
30 ,,	33	37	25	36	34	36	33	34	34	33	34	35
35 ,,	29	33	31	32	30	32	29	31	30	29	30	31
40 ,,	25	29	27	29	26	28	25	27	26	26	26	28
45 ,,	22	25	23	25	22	25	22	24	22	22	22	24
50 ,,	18	21	20	21	18	21	18	20	18	18	18	20
55 ,,	15	17	16	17	15	17	15	16	15	15	15	16
60 ,,	12	13	13	14	12	13	12	12	12	11	12	13
65 ,,	9	10	10	11	10	10	9	9	9	9	9	10
70 ,,	7	7	8	8	7	7	7	7	7	7	7	7
75 ,,	5	5	6	6	5	6	5	5	5	5	5	5
80 ,,	3	4	4	4	4	4	3	3	3	4	3	4

3. Locality.—The first thing to be considered under this head is the effect of locality on fecundity; and on this subject the data are unfortunately very incomplete. The fecundity of the inhabitants of even neighbouring countries varies greatly: thus in England the ratio of births to the number of inhabitants is 1 to 35·0; in France, 1 to 31·6; Sweden, 1 to 27·0; and in Prussia, 1 to 23·3. It is stated that 'the places which produce annually the greatest number of marriages are those where the fecundity of marriages is least;' and also, 'that the countries where

marriages are most numerous are those where the mortality is greatest.'

The death rate also varies in different countries: thus in England it is about 1 in 51·0; in France, 1 in 39·7; in Sweden and Belgium, 1 in 47·0 and 1 in 43·1 respectively.

The reports of births and deaths of Scotland make three divisions of the people.

1. Those living on the islands.
2. Those living in the country of the mainland.
3. Those living in the great cities.

During the fourteen years reported, the proportions of deaths of children for every 100 births in each class were—

	UNDER ONE.	UNDER FIVE.
Islands, ...	8·05	15·58
Mainland Country, . .	9·80	18·56
Cities, ...	14·91	30·90

4. PERIODS.—At different periods in the same country we find a marked difference between the number of marriages, births, and deaths. Thus at certain periods when corn was cheap and the cost of living small, there were more marriages followed by an increase of births than at those periods when corn was dear, the result of either the effect of bad harvests or war. The number of the deaths varies also at different epochs. The mortality is not increased during the period of famine, but during the years which follow, as a result of the diseases brought about by want of proper food.

5. SEASONS.—The number of births and deaths is more or less affected by the seasons of the year: thus the maximum of deaths occurs about the month of January, that of births during February; the minimum of both being reached about July. The effects of winter having passed off, and the vital

forces being most active, most conceptions take place in May, followed by an increase of births in the following February. The effect of the seasons is more marked in the country than in the towns.

Certain diseases are more common at one season of the year than at another. Thus scrofula is more general in spring than at any other time of the year; and it was towards the end of spring, when the tendency to alleviation or cure was strongest, that those afflicted were brought to have the royal touch. Summer brings with it gastric and liver complaints; autumn, fevers and miasmatic diseases; and winter, diseases of the respiratory organs—pneumonia, bronchitis, phthisis, etc.

The state of civilisation to which the inhabitants of a country attain, is in a great measure due to the seasons.

Agriculture flourishes in countries where the seasons are favourable; and in no country was this more noticeable than in Egypt. The regular overflow of the Nile at a certain time of the year made Egypt the granary of the ancient world. As a nation becomes more agricultural, it becomes more civilised.

6. Hours of the Day.—There can be no doubt but that man is more liable to be attacked by disease during certain hours of the day than at others. More deaths occur during the early hours of the morning than at any other time. There is greater liability to attacks of epidemic diseases during the night. 'On referring to the experience of cholera in this country, it appears that the great majority of seizures were between twelve at midnight and six in the morning.' In Hamburg the attacks were so generally in the night, that, when the epidemic was at its height, many persons were afraid to go to bed at all; and it is remarkable that the same observation has been made with respect to plague, when it prevails as an epidemic.' Dr. Laidlaw says, 'I do not recollect to have been called to a fresh case of plague

till between five and six in the morning.' This liability to disease during the night is probably due to the diminished activity of the function of respiration and to the lowered tone of the system. The number of births is greater during the night than during the day, the ratio being as 5 to 4.

B. Moral or Disturbing.

Professions; state of morality; marriage and prostitution; institutions, civil and religious, affecting the number of births and deaths.

1. PROFESSIONS AND TRADES.—The influence of professions and trades on the birth rate of a country is in general masked by other forces, the exact influence of which is not easily determined; but their effect on the number of deaths is more easily appreciated. The clergy are proverbial for large families. A state of slavery appears to diminish the fecundity of marriages. With regard to the effect of professions and trades on the mortality of a country, more definite data have been obtained.

The state most favourable to man is that in which he leads a regular life, with sufficient for his wants, without having his passions excited by the profligacy of the towns.

Certain professions and trades are more obnoxious to long life than others. Thus the researches of the late Professor Casper, contrary to the generally received opinion, show that the medical profession is perhaps more liable to early death than any other, and that the clergy in the list of mortality occupy the opposite extreme. Idleness and affluence are fruitful sources of disease.

All those professions which from their very nature enjoin a more or less sedentary life are injurious to health, and therefore to longevity. Lawyers confined to the desk, schoolmasters, clerks, literary men, and others precluded from taking exercise in the open air,

are as a class short-lived. Literary men unfortunately lead most irregular lives, which may, more than their occupation, tend to shorten life.

Merchants are generally considered long-lived; but it is not improbable that the formation of railways, with the rapidity of transit and the uses of the electric telegraph, which diminishes the dimensions of the earth, will have at no far distant date most injurious effects on the mercantile population. The rapidity with which the news of the fall in prices of the markets is now transmitted, and the anxiety to sell at once to save loss, or to buy in the hope of future profit, is gradually leading to a train of evils for which the future must suffer.

Shopmen confined all day to close, ill-ventilated shops, going to bed late and rising early, with little outdoor exercise, except on Sunday, when they are glad to rest after the labours of the week, frequently fall victims to phthisis, and die early.

Stone-masons, lapidaries, knife-grinders, quarrymen, coal-miners, and coal-heavers are subject to phthisis. *Grinder's rot* is a form of consumption well known among knife and needle grinders.

Shoemakers, from their sedentary habits, suffer in most cases from piles and from the pressure of the last on the breast-bone. Soldiers and sailors, if the former are not selected at too early an age, and the latter when they escape the perils of their calling, are generally healthy and long-lived. The effect of recruiting the French army in the time of Napoleon with very young men was, that 'they encumbered the road-sides and the hospitals.' The earliest age at which the recruit should be admitted into the army is twenty.

On the whole, then, those professions and trades which admit of a due exercise of the healthy functions of the mind and body, together with a due amount of outdoor exercise, are conducive to long life; the contrary, to early death.

2. Morality.—Marriage and Prostitution.

a. Marriage.—Marriage in young nations becomes a necessity. In many ancient nations marriage was strictly enjoined, and in some enforced by penal statutes. In more modern times much is left to individual pleasure. Promiscuous intercourse of the sexes has a tendency to diminish the number of births, and to lessen the natural expectation of life. There are more still-births among illegitimate than legitimate children, and the mortality is also greater during the early months of infantile life. 'Le funeste héritage,' says Quetelet, 'du vice n'atteint pas seulement l'enfant avant sa naissance, il le poursuit longtemps après qu'il a échappé à ce premier danger ; et la misère bien souvent aggrave encore le mal.' Married men live longer than the unmarried.

b. Prostitution.—This is one of the most difficult questions which may engage the attention of the State. That prostitution is a terrible evil, no one will deny ; but few are agreed as to the measures to be adopted for its suppression. Besides the terrible diseases which promiscuous intercourse of the sexes engenders, the effect on the morals of the community is not less disastrous. In foreign countries the State has interfered, and prostitution is to a great extent regulated by State enactments. In the years 1864, 1866, 1869, certain Acts were passed, known as the *Contagious Diseases Acts ;* but these, unfortunately, only apply to certain towns used as naval and military stations. Much opposition has arisen with regard to these Acts among a small number of very well-meaning but misguided philanthropists, among whom may be noticed a few married and unmarried women. In no other country but England is prostitution so open and so undisguised. 'The effect of this,' writes Dr. Parkes, 'upon the virtuous female population is very serious. Every servant in London sees the fine clothes and hears of the idle and luxurious lives of the women of

the town, and knows that occasionally respectable marriage ends a life of vice. What a temptation to abandon the hard work and the drudgery of service for such a career, of which she sees only the bright side! It is a temptation from which the State should save her. She should see prostitution as a degraded calling only, with its restrictions and its inconveniences.' If a means of gratifying the sexual instincts is imperative, and marriage is not possible in all cases, the unfortunate women, who may as a rule be regarded as the victims of male licentiousness, should be properly registered, domiciled, and placed under organized medical inspection. They should not be allowed to patrol the streets of our towns decked out in the most captious apparel, and enticing by their meretricious actions the young and the unwary.

3. Civilisation.—No one can doubt the beneficial influences of civilisation on the well-being of a country; and this influence is most marked in the diminished mortality among children, and the greater prolongation of human life. 'I don't fear contradiction,' says the late Professor Graves, 'when I assert that the prolongation of human life is a decided advantage; because, in proportion as the judgment of the old is brought to act on the passions of the young, will the wisdom of nations accumulate, and the solidity of individual character be increased.' But civilisation, though good in itself, unfortunately brings with it in most cases the means of over-indulgence with its train of evils.

Liberal institutions are most favourable to fecundity; and during periods of peace and plenty the number of marriages increases, with a consequent increase in the number of births. It is stated that in Catholic countries, where Lent is rigidly observed, the number of births is materially diminished. It appears also as well established, that civilisation has great power

in diminishing the mortality. The following table gives some important results, and is taken from the Geneva records.

The Deaths in 10,000 *Born were*—

PERIOD.	UNDER 1.	UNDER 3.
Sixteenth Century	2·592	4·435
Seventeenth ,, ...	2·372	4·100
Eighteenth ,, ...	2·012	3·316
1814 to 1833	1·385	3·440

In the first period, one half died before they completed their ninth year; in the last, one half survived their forty-fifth year.[1]

The injurious effects of overcrowding is well known. Dr. Farr remarks, in the Fifth Annual Report of R. G., p. 419, that the mortality is not only greater in town than in country districts, 'but that the mortality of town districts has a certain relation to their density.'

The following table will show the result of Overcrowding on the Annual Mortality per 1000 *in the Metropolis.*

SPACE FOR EACH PERSON.	MORTALITY.
32 square yards, ...	27·7
102 ,, ...	24·4
202 ,, ...	20·0

Emigration.—This subject has become a matter of great importance, as the necessity of getting rid of our surplus population becomes more imperative.

Some have suggested the creation of small landed proprietors. This is admirably combated by a writer in the *Quarterly Review* for January 1872. He says—

[1] See valuable article on 'Infant Mortality' in the 'Report of the Board of Health, Massachusetts.'

'We feel the full beauty of the pictures they draw of the smock-frocked labourer sitting at his own door, under his own fig-tree, looking out on his own ten acres, and with his ten children—which he is sure to have—lying on the sward around him. But when we think of the next step, and picture each of these ten children needing his ten acres also, the economic imagination breaks down before the unrealizable ideal. These peasants are *too thick upon the ground already*,—that is the fundamental cause of their wretchedness; unless they emigrate, they will become thicker still, and rapidly so—and what then?'

4. INTEMPERANCE.—On this subject I shall quote somewhat largely from some valuable papers in the Annual Report of the State Board of Health of Massachusetts, kindly sent me by Dr. H. I. Bowditch.

'*First.*—Stimulants are used everywhere, and at times abused, by savage and by civilised man. Consequently, intoxication occurs all over the globe.

'*Second.*—This love of stimulants is one of the strongest of human instincts.

'*Third.*—Climatic law governs it.

'*Fourth.*—Owing to this cosmic law, intemperance is rare near the equator.

'*Fifth.*—Intemperance causes little or no crime toward the equator. It is the almost constant cause of crime, either directly or indirectly, at the north, above 50°.

'*Sixth.*—Intoxication is modified by race, as shown in the different tendencies to intoxication of different peoples.

'*Seventh.*—Races are modified physically and morally by the kind of liquor they use, as proved by examination of the returns from Austria and Switzerland.

'*Eighth.* —Beer, native light wines, and ardent

spirits, should not be classed together, for they produce very different effects on the individual and upon the race.

'*Ninth.*—Light German beer and ale can be used even freely, without any apparent injury to the individual, or without causing intoxication. So also may light grape wines, unfortified by an extra amount of alcohol.

'*Tenth.*—Races may be educated to evil by bad laws, or by the introduction of bad habits.

'*Eleventh.*—A race, when it emigrates, carries its habits with it, and for a time at least those habits may override all climatic law.'

Twelfth.—In this Dr. Bowditch is somewhat hard upon England. 'England has thus overshadowed our *whole* country with its love of strong drinks and with its habits of intoxication, as it has more recently covered Ceylon, parts of the East, and Australia.'

The other divisions, nineteen in number, relate chiefly to suggestions for suppressing drunkenness in America.

'The present intemperate condition of the English is due to several causes, among which may be noticed —bad legislation and war. The prohibitive duties on light French wines forced the English to seek in Portugal the strongly fortified port. This has been unfavourable to the moral status of England.' Macaulay states that wine was given up in 1648, and that punch took its place; and worse than the change of brandy and lemonade for claret, was the increase of crime in 1692. 'As a warning to our people,' says the writer of the paper, 'by our present unwise and high tariff on the mild wines of Europe, the people of this country are led to use the only drinks provided for them, viz. the coarser liquors. Are we not, in so doing, following exactly in the absurd way, I do not say wicked example, set by England two centuries ago? The civilisation of monarchical Britain of the

17th century governs, in fact, republican America of the 19th.'

INDIVIDUAL MAN.

Man, whether considered as an individual or as a species, is affected by the same influences. 'Man,' says Draper, 'is the archetype of society, individual development, the model of social progress.' In the following pages man will be briefly considered as an individual, under three heads:—

1. HEIGHT. 2. WEIGHT. 3. STRENGTH.

1. HEIGHT.—The length of the new-born infant varies from 16 to 24 inches, the males being as a rule somewhat longer than the females. Towards the age of 16 to 17 the increase in the height of girls is relatively less than of boys between 18 and 19. This may be due to earlier accession of puberty in the female than in the male. It appears also that the average height up to the age of 19 of those living in the country is greater than those who live in the towns; but that the average height of those who have reached the age of maturity is greater in the towns than in the country.

Much will, of course, depend upon the ease with which the necessaries of life are procured, and also a freedom from those influences which in early childhood have a tendency to dwarf the stature. It is also found that up to the age of puberty the height does not materially differ among the children of the lower classes, whether engaged in factories or not; but that it is after that period that the difference in favour of those who are not employed in factories is most marked.

The following are the conclusions arrived at by M. Quetelet, from an extensive examination of this subject:—

'1. That the most rapid growth takes place immediately after birth, the infant growing in the course of one year about six inches.

'2. That the growth of the infant diminishes in proportion to the increase in age, up to the fourth or fifth year, the period at which the maximum probability of life is reached. During the second year after birth the increase of growth is about half what it was during the first, and a third during the third year.

'3. Reckoning from the fourth to the fifth year, the increase of growth becomes nearly regular as far as the sixteenth year, that is to say, just after the age of puberty; and this annual increase is about two inches.

'4. After the age of puberty the height continues to increase but slowly. From the sixteenth to the seventeenth year the increase is about one inch; in the two following years, about three-quarters of an inch.

'5. The growth of man does not appear to entirely terminate at twenty-five years of age.'

The following results are also taken from M. Quetelet:—

'1. The limit of growth of the two sexes is unequal.

'*a*. Because the female at birth is smaller than the male.

'*b*. Because she arrives earlier at her full development.

'*c*. Because her annual increase is somewhat less than the male.

'2. The height of the inhabitants of towns at the age of nineteen is greater by half an inch to three-quarters than that of those who live in the country.

'3. It does not appear that the growth of man is arrested at twenty-five.

'4. Those individuals who live in ease and comfort generally exceed the average height; want and misery have a contrary effect, as obstacles to development.

'5. The increase in the growth of the infant for many months before birth, until development is complete, follows the same law, viz. that the rate of increase diminishes with the age.

'6. Between the ages of five and six, or thereabouts, the annual increase is pretty regular, and it is a twelfth of the increase of the fœtus during the month which precedes birth.

'7. In short, reckoning from the age of fifty, the man and the woman undergo a diminution in height which is more or less marked, and which may be estimated at from two to two and a half inches, till eighty years of age.'

Certain external forces more or less affect the full development of man. Thus the average height is less in very cold or very hot climates than it is in those countries where the climate is more temperate. Men are taller in the plains than in mountainous districts. The variety and ease with which food is obtained have a modifying effect. Some diseases, particularly fevers, have a marked effect in causing a rapid increase of growth. (See the article on Giants in *Dictionnaire de Médecine.*) Lying in bed is also favourable to growth. A man is found to be taller in the morning than at night.

2. WEIGHT.—At birth the weight of the infant varies from six to nine pounds; sometimes the latter is exceeded by a few pounds. Male children are also slightly heavier at birth than female. M. Chaussier —quoted and corroborated by Quetelet—states that the infant decreases in weight immediately after birth to the third day, and that it is not till after the first

week of extra-uterine life that any increase in weight becomes appreciable. Weight up to a certain age increases with the height. After fifty years of age the height and weight gradually decrease. From birth to puberty the male is slightly heavier than the female, but at that period they are about equal, the male again having the advantage with increase of age. At the age of forty man reaches the maximum of his weight, and at eighty he has lost more than twelve pounds of his weight. The woman attains her maximum of weight at fifty. Reckoning from about the age of nineteen, her weight does not vary much till after the catamenia have ceased.

When fully developed, the male and the female weigh about twenty times what they did at birth, and are about three and a quarter times the height they were at the same period. Infants a year old are three times the weight they were at birth; at six they are twice as heavy, and at thirteen four times as heavy as they were at one year. Immediately before puberty both sexes weigh about half of their ultimate weight.

From birth and during the first year the weight of the child is the cube of the height, but after this period to puberty the growth is less rapid; the weight is then the square of the height.

As the relative weight and height of individuals given by Quetelet apply more particularly to Belgium, I have not inserted them here; but the following table of Dr, Hutchinson, based upon 2650 observations, may be taken as a standard:—

	Feet.	Inch.		St.	Lb.
A person	5	1	high should weigh	8	8
,,	5	2	,,	9	0
,,	5	3	,,	9	7
,,	5	4	,,	9	13
,,	5	5	,,	10	2
,,	5	6	,,	10	5
,,	5	7	,,	10	8

	Feet.	Inches.		St.	Lb.
A person	5	8	high should weigh	11	1
,,	5	9	,,	11	8
,,	5	10	,,	12	1
,,	5	11	,,	12	6
,,	6	0	,,	12	10

3. STRENGTH.—The strength of man is measured by an instrument contrived by M. Rignier, and called by him a 'dynamometer,' from δυναμις, *force, vital power*, and μετρον, *measure.* This instrument is by no means as perfect as could be wished.

According to Rignier, a man 'from 25 to 30 years is in the zenith of his strength, and ought to press with both his hands with a force equal to about 100 pounds, and on the other hand he should be able to lift a weight of about 286 pounds. The strength of woman is considered as about equal to that of a boy from fifteen to sixteen years of age.

The following Table gives the rate of the Pulse and the number of Inspirations at different Ages.

AGES.	PULSATIONS.			INSPIRATIONS.		
	Average.	Max'm.	Min'm.	Average.	Max'm.	Min'm.
0 to 1 year.	136	165	104	44	70	23
0 ,, 5 ,,	88	100	73	26	32	23
10 ,, 15 ,,	78	98	60	26	32	23
15 ,, 20 ,,	69·5	90	57	20	24	16
20 ,, 25 ,,	69·7	98	61	18·17	24	14
25 ,, 30 ,,	71·0	90	59	16·0	21	15
30 ,, 50 ,,	70·0	112	56	18·1	23	11

LIFE ASSURANCE.

Life assurance is a contract by which a person, termed the *insurer*, in consideration of a sum of money proportioned to the risk, and technically called a

premium, becomes bound to pay the legal representatives of the *insured* at his death, or to the insured himself on his attaining a certain age, a sum of money previously agreed upon at the time of making the contract. Insurance is a consensual contract, but a written instrument on stamped paper is by statute requisite to its constitution. There are three kinds of life insurance companies: the proprietary, the mixed, and the mutual.

In *proprietary* companies a *fixed* sum is paid, the profits being divided only among the proprietors.

In the *mixed*, the insured participate in a portion of the profits, the rest being divided among the proprietors.

In the *mutual*, after paying expenses of management, the whole of the profits is divided among the insured.

Each of these modes of insurance has its advocates.

The whole system of life assurance is based on the probable duration of human life.

Several methods have been proposed by which the probable duration of life may be approximately determined.

These will now be noticed.

Life Table.—A life table is a table showing the probable duration of life. The first life table was the Breslau Table of Mortality, constructed by Dr. Halley from the registers of the town of Breslau, in Silesia; no material being then available in this country, in consequence of the ages at death being unrecorded. This table was published in 1693. Among other attempts in this direction may be mentioned Simpson's London Table of Mortality.

De Moivre's two tables.

The Northampton, constructed by Dr. Price.

The Carlisle Table.

The English Life Table, drawn from the mortality of the entire kingdom.

The experience of seventeen Life Offices' tables. The law of mortality may be best illustrated by the annexed diagram.

The 'Rate of Mortality' and 'Expectation of Life.'

a. The number of deaths, say per thousand, within any given area is known as the *rate of mortality.*

b. By the term 'expectation of life' is meant the probability of the age any one person of a given population may attain according to the rate of mortality found to prevail within that area, and ascertained as above (*a*), regard being had to the age of the party at the time of fixing the expectation.

The hypothesis of De Moivre as to the law of mortality was, that of 86 persons born, one died every year until all became extinct. According to this hypothesis, it is an even risk that on the birth of a child it will live forty-three years, the chance of living or dying before that age being equal, forty-three being the half of eighty-six years. At age twenty there are sixty-six persons living; the half of sixty-six is thirty-three, which, as the deaths are equal in each year, is the expectation of life at that age.

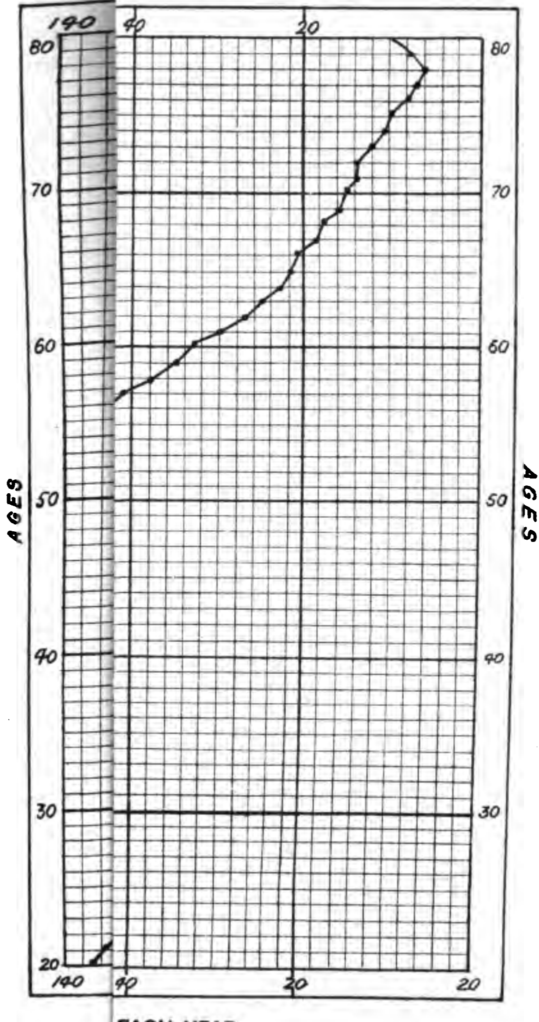
A Stationary Population.—A population in which neither increase nor decrease takes place, the deaths being no more than counterbalanced by the births. Such a population would necessarily furnish materials for a life table, but applicable only to itself.

Value to be placed on the Registration of the Causes of Death.—Mr Neison, in a letter to the Registrar-General, insists on the importance of the following six items in the registration of deaths:—

a. Place. *b.* Date. *c.* Age. *d.* Sex. *e.* Employment. *f.* Cause of death.

The value of life must necessarily depend much upon a variety of circumstances in various localities, such as occupation, liability to accident, habits, exposure to diseases, etc. etc.

EACH YEAR.



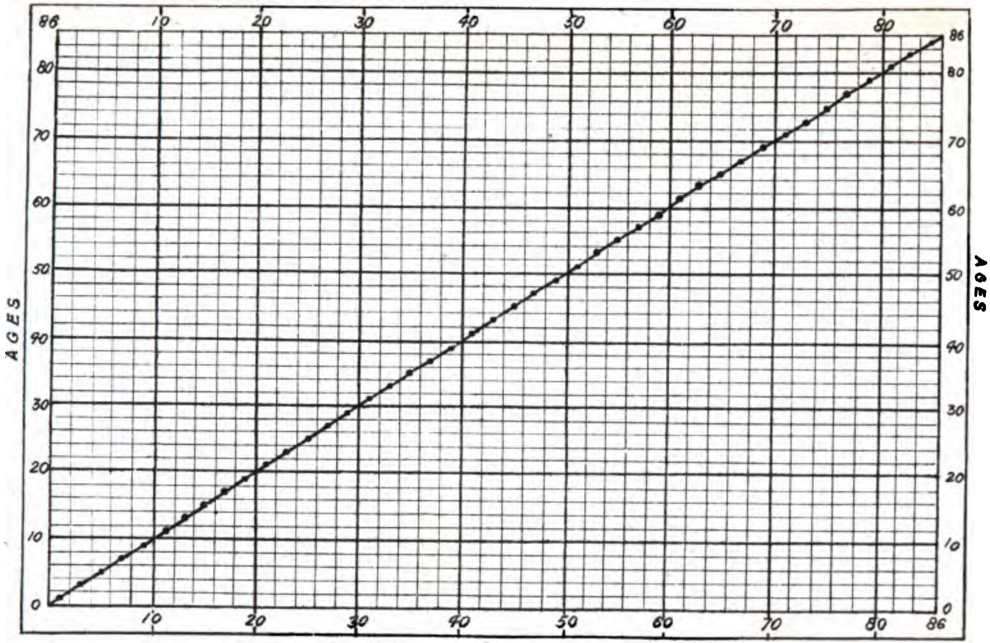
EACH YEAR.

" Table.

DIAGRAM

SHOWING DEMOIVRE'S HYPOTHESIS AS TO THE LAW OF MORTALITY.

NUMBERS OUT OF WHICH ONE WILL DIE EACH YEAR.



NUMBERS OUT OF WHICH ONE WILL DIE EACH YEAR.

It is well known that in several towns in the United Kingdom the rate of mortality varies exceedingly, doubtless from some of the causes above mentioned being more or less favourable to longevity; and Mr. Neison's suggestion, therefore, points out the true way of arriving at the real value of life at different places.

Specific Intensity.—This term, when applied to the value of human life, represents the number living at any given age divided by the number dying at that age. Females have a higher intensity of life than males.

Mean Age at Death.—The mean or average age at death of any given population is the sum of the ages at death divided by the number of deaths.

Is the mean age at death a safe measure and standard of comparison? The mean age at death can be employed with safety as a true test or measure only in those cases in which the calculation purporting to embrace an entire class is included; or in which the calculations embracing only a section of an entire class, the class in question is retained in a state of perfect uniformity during the whole time comprised in the calculation. Different populations varying in their composition, and the same population, may in course of time undergo considerable changes, and exhibit striking contrasts in the number of persons living at different ages.

The mean age at death in France is 34; Sweden, 31; England, 29.

Mean Duration of Life.—The mean duration of life is found by adding the age to the expectation of life.

Death Rate.

1. What is meant by death rate? The number of deaths occurring annually in every 1000 of the population.

2. From what data is it ascertained? From the

Registrar-General's Annual Report of the Mortality of the United Kingdom.

3. State (approximately) the mean death rate of Great Britain. The average mortality in twenty-one years was 23·15 males and 21·58 females per 1000, the mean being 22·36.

4. State some of the leading causes which raise the death rate of towns above that of rural districts.

1. Over-crowding in towns.
2. Want of fresh air and pure water.
3. Insufficient accommodation and drainage.
4. Profligate and intemperate habits.
5. In London and other large towns many die in the hospitals who ought to be accredited to the country. The death rate of many watering-places is great only on account of the numbers who go for the benefit of health, but really to die.

The death rate of model dwellings for the poor is most probably fallacious, especially during the first few years of their tenancy; for, as Dr. Rumsey remarks, 'the earlier inhabitants of these model lodgings would naturally belong to a better-conditioned order of working people. Their selection of such dwellings would indicate the possession of a higher taste, greater frugality and temperance, and more adequate means of livelihood than the average of their class. Besides, the ratio of mortality in any small and isolated population, as I have before said, is, and must always be, a fallacious test of its ratio of unhealthiness.'

ENDEMIC DISEASES.

The action of endemic influences on the animal economy was held by Cullen to be a direct sedative, not merely lowering the vital power, but also inducing spasm of the extreme capillaries. If the vital

energy of the system was not entirely overpowered, reaction supervened and fever became developed. Some hold the opinion that marsh effluvia acts as a stimulant or irritant, and that the debility which it evidently occasions is consecutive on a state of exhaustion. These opinions do not, however, explain all the phenomena of these diseases. The sources of endemics are—

a. Low marshy places.
b. Ground subject to inundation, or saturated with moisture.
c. Woods, jungles, etc.
d. Presence of decaying animal and vegetable matter.

Prevention.—Drainage, embankments, flooding the marshes with water,—in fact, turning the marsh into a lake; clearing the soil of wood, and cultivating it.

EPIDEMIC DISEASES.

Epidemic diseases are diseases which prevail occasionally and at uncertain intervals, but which may last for months.

Sources.—Certain endemic influences just mentioned, and a condition of the atmosphere of whose exact nature we are utterly ignorant. Some epidemics are peculiar to certain seasons. Sydenham remarks 'that all epidemics are referable to one of two classes. They are either *vernal* or *autumnal.* Even when they originate during some other period of the year, they must be referred to one of these divisions, spring or autumn, whichever they are nearest to, just as the case may be. For it happens occasionally that the atmospheric influences may so coincide with an epidemic as to forward its development, and to precipitate it, as it were, prematurely upon its victims.'

Spring—Croup, exanthemata, etc.
Summer—Fevers, bowel complaints, etc.

Autumn—Diseases of summer, etc.
Winter—Influenza, etc.

AIR.

The atmosphere consists of a mechanical mixture of two gases, oxygen and nitrogen. The former is the active agent in supporting animal life and promoting the combustion of bodies; the latter acts simply as a diluent, and modifies the activity of the oxygen. The proportion of oxygen to nitrogen is as 1 to 4, and this proportion always remains the same.

But owing to the escape of the products of combustion, of respiration, and the decay of animal and vegetable substances, the atmosphere becomes charged with aqueous vapour, carbonic acid, ammonia, etc.

To ensure the maintenance of health in man, it is absolutely necessary that the air he breathes should be as pure as possible, and also that the quantity be sufficient for his wants.

A healthy man draws into his chest between 20 and 30 cubic inches of air at each inspiration; and this multiplied by the number of inspirations (15 to 16) per minute, gives the amount of respired air per minute; and this again multiplied by 60, the amount per hour. For example:—

$30 \times 16 = 480$ cubic inches.
$480 \times 60 = 28{,}800$ cubic inches, or 16·66 cubic feet per hour.

Now, it is found that the inspired air contains about 0·4 volumes of CO_2 in 1000, whilst the air expired contains about 40 volumes of CO_2 per 1000, besides watery vapour and other impurities.

To reduce the carbonic acid of the expired air to the normal amount, 125 times the volume of expired

air must be supplied per hour, as the exhalation of CO_2 from the skin must also be taken into the calculation. Thus, $16{\cdot}66 \times 125 = 2082{\cdot}50$ gives the cubic feet required per hour for each individual.

IMPURITIES OF AIR.

The impurities of air may be classed under two heads—

1. *Suspended Matters.*

The spores of certain plants, the germs of bacteria and other creatures, particles of carbon from factories, and portions of the materials used in certain industries, together with a host of other substances which find their way into the atmosphere and are carried from place to place by the winds.

2. *Certain Gaseous Substances.*

Hydrochloric acid, ammonia, sulphuretted hydrogen, sewage gases, carburetted hydrogen, vapours from decaying animal and vegetable bodies, etc.

PURIFICATION OF AIR.

Besides the purifying effect of ventilation, other methods are adopted to render air fit for human respiration.

1. *Solids.*

Certain substances act chemically on air; thus wood charcoal is used to purify the air issuing from drains and cesspools. Unslacked lime is used to absorb carbonic acid when present in abnormal quantities in wells, etc.

2. *Liquids.*

A solution of nitrate of lead will remove the sulphuretted hydrogen from cesspools. Solution of

chloride of zinc (Sir W. Burnett's fluid) destroys organic matter. Solution of permanganate of potash (Condy's fluid) destroys organic matter, and decomposes ammoniacal compounds.

3. *Gases.*

Nitrous Acid.—Acts on organic matter, but it must be used with care, as it may in some persons cause severe irritation in the lungs.

Chlorine.—Decomposes sulphide of ammonium and sulphuretted hydrogen.

Sulphurous Acid.—Destroys organic matter, and, according to Guyton de Morveau, it destroys miasms.

The vapours from iodine and bromine have been used with doubtful success.

Ozone.—Ozone may be developed artificially by passing electric discharges through air or oxygen, by the slow oxidation of phosphorus in air, and by the electrolysis of water acidulated with sulphuric acid. It appears to be a powerfully oxidizing agent, bleaching most vegetable colours. It has the property of bluing starch paper heated with iodide of potassium by setting free the iodine. This change may also be effected by any nitrous acid present in the atmosphere. A better test is the bluing of litmus paper slightly reddened and impregnated with iodide of potassium; ammonia being the only gas which has a similar reaction. But this source of error may be obviated by noticing that reddened litmus paper, not impregnated by the iodide, is blued by ammonia, but not by ozone.

Direction or movement of the air in a room may be determined by burning brown paper and noticing the direction taken by the smoke, or the direction taken by small particles of light substances, or the effect produced on the flame of a candle. The velocity may be determined by an *anemometer*, by the *manometer*, or by *calculation*.

EXAMINATION OF THE AIR.

Substances to be looked for—

1. *Suspended Matters.*

Detected by the microscope, the air being previously drawn through an aspirator over glass slides moistened with glycerine, which collects all the solid matter suspended in the air.

2. *Organic Matter.*

Determined by a solution of permanganate of potash and oxalic acid.

3. *Carbonic Acid.*

Degree of milky coloration, with a standard solution of lime.

Watery Vapour.

Determined by various forms of hygrometers.

Ammonia.

See account of the Nessler test, p. 318. To perform this test the air must be drawn through distilled water, previously tested as to its freedom from ammonia.

VENTILATION.

The importance of a knowledge of the principles of ventilation cannot be over-estimated. In considering this subject, there are three important points to be borne in mind.

a. The capacity of the room, that is, the amount of cubic space which it contains.

b. The number of individuals normally present in it.

c. The efficiency of the means for introducing pure air, and allowing the vitiated to escape.

1. The entering air must be pure, and of a proper temperature.
2. There should be no draught. The rate at which the air moves through the room depends somewhat on the temperature. A velocity of from 1 to 2 feet per second, at a temperature of 60° F., will not cause a draught, and will yet answer the purpose of ventilation.
3. The air must be diffused through the room; in no part ought it to remain stagnant.
4. There must be means provided for the escape of the foul air, and entrance of the pure.

The minimum amount of space allowed by the Poor Law (Local Government) Board in dormitories is 300 cubic feet.

In calculating the cubic space of any given apartment, the height, length, and breadth must be multiplied together, allowance being made for any recesses, cupboards, and also for the bodies of the occupants, an average of three cubic feet being allowed for each individual. The space occupied by articles of furniture must also be considered. If the room be irregular in shape, it must be divided into several portions, the sum of which will give the size of the room. After these various corrections, the remaining number of cubic feet divided by the number of individuals will give the cubic space per head.

Ventilation may be either *natural* or *artificial.*

Under natural ventilation may be classed all those naturally operating causes by which foul air is removed, and pure air introduced without the aid of any mechanical means.

Artificial ventilation, on the other hand, includes all those appliances which may be strictly termed mechanical. Many of these so-called mechanical

appliances owe their efficiency to the utilization of already existing natural agencies. In natural ventilation, the efficient cause is the expansion of air by heat, aided by the well-known diffusive property of gases. The air of the room heated by respiration and by contact with the human body, at the same time becoming vitiated by the products of respiration, rises to the upper part of the room, and then escapes by any outlet which it may find. A vacuum occurs, fresh air rushes in from any orifice situated near the ground, such, for instance, as the chinks of doors, and thus by natural means ventilation is established. Fires in open grates act in a similar way; a strong upward current is caused by the warm air rushing up the chimney, and cold air from without supplying its place. Modern fire-places only ventilate as high as the opening into the chimney, the air above the mantelpiece remaining stagnant. Chimneys without fires act as useful ventilators; for the wind blowing over their tops creates a partial vacuum, which is being constantly filled with air from the house. As suggested by Dr. Arnott, a hole should be made into the chimney close to the ceiling. 'A top window-sash, lowered a little, instead of serving, as many people believe it does, like such an opening into the chimney flue, becomes generally, in obedience to the chimney draught, merely an inlet of cold air, which first falls as a cascade to the floor, and then glides towards the chimney, and gradually passes away by this, leaving the hotter, impure air of the room nearly untouched.' Several forms of valves for placing in holes near the ceiling have been invented; but a description of their individual merits is not necessary here. One objection to Arnott's hole in the chimney is, that sometimes a down draught forces soot into the room.

By Sylvester's plan, the agency of the wind is utilized by the aid of a cowl, which is constantly

directed to that quarter from which the wind blows. The cowl is connected to pipes distributed throughout the house, and through which the fresh air enters the various rooms.

As an example of the strictly mechanical means by which ventilation may be effected, the case of the Senate House in America may be mentioned. In this, a large fan, worked by a steam-engine, draws in the fresh air, which, after being warmed by passing over hot pipes, is distributed throughout the house, the amount of air supplied being regulated by calculating the quantity required for each individual present. Whichever method be adopted, the remarks of Mr. Tomlinson should be borne in mind, that 'in the rooms of private houses the ventilation must also be spontaneous; for if the slightest trouble be entailed on the inmates, even to the opening of a window, it will be neglected. The means for ventilation must be cheap, easily procurable, always in place, self-acting, not liable to get out of order, requiring no adjustment, no care whatever on the part of the inmates.'

CLIMATE.

Climate may be said to embrace all those physical influences connected with the soil, heat of the atmosphere, or the water of a place, which, acting and reacting upon man, more or less materially affect him.

The climate of a place depends upon a variety of circumstances. Thus we have the modifying effects of large forests and luxuriant vegetation, which, protecting by their shade the soil beneath from the direct influence of the sun's rays, exhale, in the interior of a country, at places a great distance from mountains and the ocean, large quantities of moisture, at the same time rendering the air of the place cooler.

The presence of large rivers and lakes, and the close proximity of a vast ocean, together with lofty mountains rich in springs, with snow-capped summits rising above all the strata of the clouds, and causing descending currents of cold air to roll down their sides, must of necessity exert a powerful influence on the climate of a country. The trade winds sweeping freely over a large expanse of water acquire thereby a cooler temperature, which they impart to the countries along whose shores they blow.

Sandy deserts, on the other hand, by radiating the heat imparted to them by the sun, increase the temperature of surrounding countries.

The severity of the climate on the coasts and in islands is diminished by the absorption during the summer by the sea of the sun's rays, which penetrate deeper into it than into the land. Due to its saltness, it does not freeze so soon as fresh water; and imparting its heat to the winds that blow over its surface, it affects the temperature of the countries situate on its margins. The large expanse of ocean in the south hemisphere, producing a warm, moist atmosphere favourable to luxuriant vegetation, is strikingly contrasted with corresponding latitudes in the north, where, from excess of land, the air is rendered cold and dry, and the land for the most part barren.

Climate is divided into continental, insular, or sea climate, and mixed.

A *continental* climate consists in a cold winter and a hot summer.

An *insular* climate is characterized by a cool summer and mild winter.

A *mixed* climate is inclined to be continental in winter and insular in summer.

Asia is an example of the first, Europe of the second, and North America of the third.

Climate cannot be determined exclusively by mean temperature, as places often differ materially in

climate, although having the same mean annual temperature. This arises from the circumstance that an extreme degree of heat in summer and cold in winter in one place, may give a mean annual temperature not materially differing from another place having a more equable temperature throughout the year.

Isothermal lines are lines drawn on a globe or map through places having the same mean annual temperature.

The mean temperature of *a day* is absolutely determined at Greenwich by marking the height of the thermometer at every moment of the day by the aid of photography. This may also be roughly estimated in several ways—

1. By taking the mean of the readings of the thermometer for every hour of the day.
2. By taking the mean of the maximum and minimum readings on the same day of the thermometer placed in the shade.

The mean temperature of *a year* is found by adding together the monthly ranges, and dividing them by twelve.

The mean temperature of *a place* is determined by adding together the mean temperature for several months, and then dividing by the number of the months during which the observations have been taken.

TOWNS.

In selecting a site for a future town, the following points must be carefully considered. Topographical position :—

a. Elevation above the level of the sea.
b. Purity and hygrometric state of the atmosphere.
c. Vicinity of rivers and streams, and the supply of good potable water.
d. Vicinity of hills and mountains.

e. Vicinity of marshes.

f. Vicinity of the sea.

g. Vicinity of trees and forests.

h. Efficient drainage and sewerage.

In the selection of a station or camp, besides the above, it will be necessary to see that there is a good supply of fuel for cooking and warming purposes.

a. Elevation above the Level of the Sea.

Due to the lessening amount of earth to absorb the rays of the sun, and also to the greater amount of radiation into space, the greater the elevation the colder the air.

b. Purity and Hygrometric State of the Atmosphere.

The normal constitution of the atmosphere consists of a mixture of oxygen, nitrogen, and aqueous vapour, with traces of carbonic acid. The amount of aqueous vapour depends upon the temperature and pressure of the atmosphere, but the proportions of the gases present are nearly the same everywhere.

Humidity.—This term is held to imply the amount of vapour present in the air, and also the ratio of this to the amount which would saturate the air at the actual temperature. The amount of vapour in the air is not a measure of its humidity, for the air is for the most part drier in summer than in winter, although the amount of vapour present is much greater.

The humidity of the atmosphere may be directly determined by Daniel's or Regnault's hygrometer, or by means of the dry and wet bulb thermometer.

The *dew point* is the temperature when the air is just saturated with moisture, so that the least further fall would cause a deposit of dew, rain, snow, or hoarfrost, according to circumstances.

Formation of Clouds.—Clouds are formed by the condensation of vapour in a stratum of air at a low

temperature, and at a considerable height—one to four miles—above the surface of the earth.

There are three varieties of clouds usually recognised by meteorologists as follow :—

1. Cirrus. 2. Cumulus. 3. Stratus.

1. *Cirrus*, or the *Mare's Tail* of sailors, occupies the highest region of the atmosphere. It is higher than any point yet reached by balloons, and is probably composed of small particles of ice.

2. *Cumuli* consist of rounded masses resting on straight bands, and having the appearance of hills or mountains. Sometimes they present the form of *balls of cotton* or *wool packs*, by which names they are known to sailors. They are most common in summer.

3. *Strati* consist of horizontal sheets, which form at sunset and disappear at sunrise. The strati are the lowest clouds. Besides these, which are the primary forms, there are several combinations of the above described, viz. *cirro-stratus*, *cumulo-stratus*, and the *cirro-cumulus*.

The cirro-cumulus forms the well known *mackerel sky*.

Any cloud discharging rain has had the term *nimbus* applied to it.

A *mist* is a cloud close to the ground.

A *fog* occurs when the surface of the ground is warmer than the air in contact with it. The fogs in Newfoundland are due to the excess of heat of the Gulf-stream above the cold moist air on its surface.

Rain.—As the clouds consist of particles of water, they are constantly raining; but between the clouds and the earth there is usually a non-saturated belt or region, where these particles of water when small are usually evaporated before they reach the earth. When this belt becomes saturated, the particles coalesce, and rain is the result.

Mode of estimating the Rainfall.—There are several forms of rain gauges. The simplest consists of a funnel

opening into a receiver in which the rain is collected, and from which it may be drawn and measured. The funnel should have a truly horizontal rim, else the gauge will catch too much or too little, according to the direction and force of the wind.

The rain gauge should be placed *at least six inches* from the ground to avoid splashing, and in the centre of a level, open plot. From some unexplained cause, the higher the gauge is placed above the surface of the earth the less rain it catches.

According to Mr. Symons, the mean annual rainfall at London and Edinburgh is 24 inches; Liverpool and Manchester, 35 to 36; Dublin, 30; Glasgow, 40; Dartmoor, 86; and on Ben Lomond, 91.

Force and Direction of the Winds.—To determine the force and direction of the wind, various forms of anemometers are used.

c. The vicinity of Rivers and Streams, and the supply of good potable Water.

It is absolutely necessary that there should be a good supply of pure water in the neighbourhood of human habitations. Rivers are of use in the removal of sewage, and for other purposes too numerous to mention. The banks of rivers, if not carefully attended to, may become the source of disease, due to the deposit of decaying animal matter on them. In ancient Rome there were officers, 'Curatores Alvei et Riparum,' whose duty it was to take care of the banks of the Tiber, and to regulate its channel. The channels of rivers, it should be remembered, are always liable to deterioration from physical causes in constant action.

There can be no doubt but that the emptying of the sewage of a town into a neighbouring stream is an unmitigated evil. The inhabitants on the banks of rivers subject to inundations are often attacked by intermittents. It may then become necessary to

deepen the bed of the river, or to increase the velocity of its current by straitening its channel.

Potable Water.—A good supply of water for drinking and for domestic purposes is absolutely essential where any number of persons are collected together. The water should not be hard, and it should also be free from any peculiar taste or smell.

A sufficient quantity should be supplied daily to each individual. In 1852, thirty-two gallons were supplied in London daily per head, and this was increased in 1862 to fifty gallons. The amount of water required for the use of animals may be estimated at eleven to sixteen gallons per day for a horse, eight to ten for a cow, and so on for other animals.

Public baths should be erected and freely supplied with water, which should, if possible, be kept constantly flowing in and out. A certain amount should also be passed into the sewers, which has been estimated at twenty-five gallons per head per day, at the least, in addition to the rainfall.

The following table is given by Professor Rankine:—

	Gallons per Day per Head.		
	Least.	Greatest.	Average.
Used for domestic purposes, .	7	15	10
Washing streets, extinguishing fires, supplying fountains, .	3	3	3
Allowance for trade and waste, .	7	7	7
Total in non-manufacturing towns,	17	25	20
Additional demand in manufacturing towns, ...	10	10	10
Total in manufacturing towns, .	27	35	30

Various Sources of Water Supply.

1. *Rain Water.*—This ranks next in purity to distilled water, but may become contaminated by passage through the air. As a supply to large towns, it must not be trusted, for the following reasons:—

a. Uncertainty of supply.

b. The quantity falling in an inhabited country is small in proportion to the number of the inhabitants.

c. Not very palatable to the taste.

If used by small communities, it should not be allowed to remain in lead, but in slate cisterns of considerable size, and should be collected as pure as possible.

2. *Snow Water.*—Not pleasant to the taste, and is said to cause gastric derangement.

3. *Spring and Well Water.*—Water from these sources varies greatly in composition.

a. Always much harder than lake or river water.

b. Superficial wells apt to contain organic matter from churchyards, cesspools, etc., and also salts, sulphates, and carbonates—the latter kept in solution by excess of carbonic acid.

c. Deep wells contain much lime.

d. Artesian wells may contain large quantities of the alkaline carbonates and sulphates of lime.

4. *River Water* may contain organic matter from sewage, etc. As a rule, river water is very pure.

5. *Lake Water* is also a pure water.

6. *Marsh Water* is most impure.

Peaty Water is not injurious, though not pleasant to the taste.

Hard and Soft Water.—Natural waters contain varying properties of lime and other salts, and on the amount of these constituents depends the relative *hardness* or *softness* of water. The hardness of water is mainly due to the presence of the salts of lime and magnesia. When these are present in excessive quantity, such water is said to be 'hard,' and, when heated, forms incrustations on the inside of vessels,

also causing a great destruction of soap when the water is used for washing clothes and other purposes.

A *rough* means of judging of the relative degree of hardness of any sample of water, consists in placing a small quantity in a test glass and adding to it a few drops of a standard solution of soap in alcohol, when a white turbidity will make its appearance, depending in degree on the hardness of the water.

The *precise* degree of hardness is determined by ascertaining how much of a standard volumetric solution of soap in alcohol is required to form a permanent lather with a given measure of the water under examination. The above described process is known as Clark's test.

Some hard waters are softened by boiling, others are not. The hardness of such waters as admit of softening by being boiled, is due mainly to the presence of the carbonates of lime and magnesia; whilst those waters, the hardness of which is but slightly if at all affected by boiling, contain sulphate of lime. Chalk waters are among those which are most influenced by boiling; in these the carbonate of lime is held in solution by the carbonic acid present. When such a water is subjected to heat, the carbonic acid is expelled, and the carbonate of lime, no longer held in solution, is in a great measure precipitated. The hardness due to carbonate of lime is termed 'temporary,' as it can thus be removed in a great measure. The hardness due to sulphate of lime is termed 'permanent,' as it is not removable by boiling. In speaking of the 'hardness of water,' it is always desirable to know to what it is due, as, in excessive cases, this would frequently determine whether the water could be rendered fit for domestic purposes.

Nature and Origin of Deposits on Boilers.

When water containing a certain quantity of earthy salts is concentrated, not only is the carbonate of

lime deposited in the way just described, but as the solution becomes more and more concentrated the other earthy constituents are more or less completely thrown down. Thus we find that extensive deposits occur in steam boilers in which ordinary water is used, and much inconvenience frequently arises from this source, especially when this deposit assumes a compact form, from the slowness of the deposition and constitution of the water. Many schemes, both chemical and mechanical, have been proposed to obviate this inconvenience, but the treatment must vary with the character of the water. If incrustation cannot by any means be *prevented*, a plan frequently adopted is to introduce some light powdered substance into the boiler with the water. This acts mechanically by keeping up the free generation of steam; and the water being thus kept in constant and violent motion, the earthy salts are precipitated in the form of a fine powder, which is periodically removed by 'blowing out,' as it is termed. The chemical scheme which appeared most likely to prove successful, consisted in the addition of chloride of ammonium to the water in the boiler. A conversion of the carbonates of lime and magnesia into soluble chlorides was the result, while the carbonic acid passed off with the ammonia as carbonate in the steam. The great objection to the adoption of this method is, that the carbonate of ammonia, which passes off rapidly, acts on brass or copper; and this circumstance has precluded its extensive employment, except under special conditions.

There is one process in use for the prevention of boiler deposits, and likewise for the softening of water for domestic purposes, which demands special notice, —that known as *Clark's process*. This is, however, only adapted to the treatment of the chalk waters, and for these it is eminently useful. It is carried out in the following manner:—The water collected in

large tanks is treated with a sufficiency of lime-water to neutralize the free carbonic acid present. As the carbonate of lime present in the original water is only retained in solution by virtue of the solvent power of the carbonic acid, it follows that if this is in any way neutralized, the carbonate of lime must be precipitated. The lime-water acts, therefore, by neutralizing the carbonic acid, forming with it insoluble carbonate of lime, which is thus precipitated with the carbonate of lime previously dissolved in the water. By this means, not only is the lime almost entirely removed, but a certain degree of organic purification takes place by the precipitated lime carrying down with it a notable amount of the organic matter present. The above process is now in use on a large scale at several large paper mills and at other manufactories. The Kent Companies' water, notably the purest of our London supplies, obtained from deep wells in the chalk, is entirely treated by Clark's process before it is supplied to the public.

Origin of the Sulphuretted Hydrogen of Sulphurous Waters.

This is generally conjectured to arise from the deoxidizing influence of decaying organic matter on the various sulphates present in the water; the oxygen of the sulphuric acid uniting with the carbon of the organic matter to form carbonic acid, while the sulphur unites to the hydrogen, with the resulting formation of sulphuretted hydrogen.

Action of Hard and Soft Waters on Lead.

Natural waters are found to exercise very different and varying action on lead; and as the drinking water with which we are supplied almost invariably meets with lead during its conveyance from the company to the consumer, either by passage through pipes of that metal or by being stored in leaden cisterns, and,

moreover, as lead belongs to that class of poisons known as 'cumulative,' it becomes of the utmost importance that the conditions under which natural waters become charged with lead should be known. Putting aside minor distinctions, there is one broad fact which may be taken in connection with this subject, viz. that hard waters have, as a rule, very little, if any, action on lead, while soft waters are almost invariably apt to dissolve more or less of that metal. The impunity with which hard waters can be stored in leaden cisterns without injurious consequences, depends on the fact that a coating of insoluble lead salts is formed on the surface of the metal, which protects it from further action. The salt having the most protective action is the sulphate; and as ordinary hard waters almost invariably contain a varying quantity of earthy sulphates, the presence of these salts ensures our being able to use such waters with impunity. On the other hand, soft waters, having no such protective properties, are almost sure to become more or less charged with lead if allowed to come in contact with that metal; the dissolved oxygen in the water forming oxide of lead, which dissolves in the water, thus giving rise to contamination. Waters containing nitrates or nitrites in solution are especially to be avoided, as such waters frequently exercise a powerfully solvent action on lead, and have been known to corrode that metal to such an extent as to eat holes in the cistern in which the water was stored.

It is fortunate that lead is a metal which admits of easy detection when present in water, even when in minute quantities. If present to any extent, it can be immediately detected by taking a portion of the water in a tall glass jar and adding some sulphuretted hydrogen water, when, if lead is present, a brown colour will be observable, which is especially distinct if the jar containing the water is held over a piece of clean white paper. When present in minute quan-

tities, and more especially if it is desired to make a quantitative estimation of the amount present, it is better to evaporate some of the water to a small bulk, and then to acidify with hydrochloric acid. On the addition of sulphuretted hydrogen water, the whole of the lead will be thrown down as the sulphide.

Messrs. Wanklyn & Chapman have recently introduced an excellent calorimetric process for the estimation of lead in water, based upon the intensity of the brown colour developed on the addition of sulphuretted hydrogen water.

Different forms under which Nitrogen is found in Water.

Nitrogen is found in water under the following forms :—

a. Ammonia.
b. As nitrates and nitrites.
c. As nitrogenous organic matter.

Nitrogen under one or other of the above forms is found in small quantities in all waters. Some of the chalk waters invariably contain nitrates and nitrites, probably due to fossil organic remains. The sources whence the nitrogen in water is derived vary. Rain water, especially when collected near towns, invariably contains small quantities of nitrogen in the form of ammonia, dissolved during the passage of the rain through the air.

The sources of nitrogenous organic impurities are chiefly of animal origin, due to infiltration from cesspools and churchyards.

There are only two processes in use for the detection of nitrogen, viz. Frankland and Armstrong's method, by means of organic analysis; and Wanklyn & Chapman's so-called 'albumenoid ammonia method.' Frankland and Armstrong's process consists in submitting to organic analysis, by combustion with oxide of copper in a combustion tube, the residue obtained by evaporating the water under examination to dry-

ness. The gases—nitrogen and carbonic acid—liberated during the combustion are collected in a graduated tube. The carbonic acid is withdrawn by the aid of caustic potash, leaving the nitrogen, when its volume can be read off. Previous to evaporation, any nitrates or nitrites are destroyed by the addition of sulphurous acid to the water. The above process gives the amount of nitrogen present in the form of ammonia and organic nitrogenous matter.

The amount of nitrogen present as nitrates and nitrites is estimated by treating the residue of another portion of the water with strong sulphuric acid, in a graduated tube standing over mercury. On agitating the tube, the whole of the nitrogen present in the form of nitrates and nitrites is liberated as nitric oxide, the volume of which is read off and halved for the amount of nitrogen. As the evolution of hydrochloric acid gas, the result of the action of the sulphuric acid on any chloride present, would interfere with the result, all the chlorides are destroyed by the addition of sulphate of silver previous to the addition of the sulphuric acid.

Wanklyn & Chapman's process, from its simplicity, and from its not requiring the complicated apparatus necessary for the preceding process, is now coming more and more into general use.

The method is founded on the fact, that when a water containing nitrogenous organic matter is distilled with an alkaline solution of permanganate of potash, a definite portion of the nitrogen of the organic matter is liberated as ammonia, the amount thus evolved being an index of the quantity of nitrogenous organic matter present.

The process is divided into two parts—

1. The estimation of the free ammonia present in the water.
2. The estimation of the nitrogenous organic matter from the amount of ammonia

evolved by the action of the permanganate of potash.

1. About a pint or a quart of the water to be examined is placed in a stoppered glass retort, connected with a Liebig's condenser. A small quantity of a saturated solution of carbonate of soda is now added to the contents of the retort, and the whole carefully distilled. The distillation is continued until the whole of the ammonia present in the water has passed over in the distillate, known by the latter portions giving no coloration with Nessler's test. The distillate will contain the ready-formed ammonia present in the water, and the actual amount may be estimated by the aid of Nessler's test.

2. A certain proportion of a strongly alkaline solution of permanganate of potash, of known strength, is now added to the contents of the retort, and the process of distillation resumed. The distillation is stopped as soon as the last portions of the distillate cease to give the reactions of ammonia. The distillate contains all the ammonia, which may now be tested as before. The quantity so obtained is a measure of the amount of nitrogenous organic matter present in the original water.

The Nessler Test.

The Nessler test is based on the fact, that when a saturated solution of iodide of mercury in iodide of potassium, rendered strongly alkaline by the addition of caustic soda, is added to water impregnated with ammonia, various shades of a brown colour are produced. By comparing these shades of colour the presence and amount of ammonia present may be estimated. It is necessary that the ammonia solution be very dilute; for if too strong, the reagent will be either precipitated, or the delicate shades of colour, so necessary for the success of the test, destroyed by

the intense dark colour produced. In testing ordinary water, it is necessary to concentrate the ammonia in the water by distillation; but in the case of sewage, which is always rich in that substance, pure distilled water, free from ammonia, must be added to the distillate till the proper degree of dilution is obtained.

To estimate the *quantity* of ammonia present in any given sample of water, two glass cylinders, having a capacity of 1500 grains, are placed on a white surface. One is (1) filled with the solution to be tested, and the other (2) with an equal quantity of distilled water free from ammonia. Nessler's test solution, in measured quantity, is added to the first, and the shade of colour noted. A measured quantity of a dilute solution of ammonia, of known strength, is now poured into No. 2, and a measured quantity of Nessler's test added, and the shade of colour noted. Several trials are made, till the shade of colour in both cylinders is alike, when the amount of the standard ammonia used will give the quantity of this substance in the suspected water.

Wanklyn & Chapman's Method for estimating Nitrogen present as Nitrates and Nitrites.

This is a modification of Shultz' aluminium process, and is an exceedingly accurate test. About a pint of the water to be tested is placed in a retort, and a definite quantity of strong caustic soda solution added, and the whole distilled till all the ammonia has been driven off. The contents of the retort are now left to cool, and a piece of thin sheet aluminium introduced, and allowed to remain for four or five hours. Hydrogen is evolved from the metallic aluminium, which, being in the nascent state, unites with the nitrogen of the nitrates and nitrites present to form ammonia. After the action has ceased, the contents of the retort are again distilled, and the ammonia given off estimated by Nessler's test. The ammonia

thus obtained is an index of the amount of the nitrates and nitrites present.

d. Vicinity of Hills and Mountains.

In hot climates the plains at the foot of lofty mountains are often most unhealthy; but the cold air rolling down the sides of snow-capped mountains renders the valleys at their base cool and pleasant. This is strikingly noticed on the Italian side of the Alps, and also on the plains of Granada, where the cold air from the Sierra Nevada lessens the excessive heat of a Spanish summer.

e. Vicinity of Marshes.

The neighbourhood of marshes should never be selected for the site of a town; but even the deleterious effects of marshes may be lessened by proper drainage. The danger from marshes on the sea-coast appears to be greatly increased by the admixture of the sea water with the stagnant fresh water. The Littorale of Lucca, once celebrated for its unhealthiness, has been rendered healthy by stopping by means of embankments the ingress of the sea. Since the drainage in Edinburgh of the marsh once situate at the foot of the Castle Hill, endemic fever has entirely left the town.

f. Vicinity of the Sea.

As before stated, the heat of summer is modified by the presence of the sea, and the winters are rendered more bearable. In tropical countries the cool sea breezes render residence near the coast most pleasant. Sea air is also beneficial to strumous and phthisical sufferers.

g. Vicinity of Trees.

The effect produced on the climate of a place by

trees has already been noticed, p. 304. But as the movement of the air is materially affected by forests, care should be taken to keep the growth of trees within proper limits. Stations situate in the midst of dense forests are often very unhealthy. But, on the other hand, it must be remembered that trees have a wonderful power in arresting the spread of malaria; villages separated by trees from marshes do not, as a rule, suffer from malarious diseases.

In a hygienic point of view Parkes divides vegetation into *herbage*, *brushwood*, and *trees*.

Herbage is always healthy, cooling the ground as before noticed.

Brushwood is generally unhealthy, and should be removed, as the air is almost stagnant where the underwood is very thick. The removal should be effected in the middle of the day when the sun is hottest. The removal of brushwood *may* for a time give rise to malarious diseases.

Trees should be removed with care, and in most cases only when they materially affect the proper movement of the air.

h. Efficient Drainage and Sewerage.

The health of any locality in a great measure depends upon the efficiency of the drainage.

'The word "drain," 11 and 12 Vict. cap. 63, sec. 2, 'includes any drain of, and used for the drainage of, one building only, or premises within the same curtilage, and made merely for the purpose of communicating with a cesspool or other receptacle for drainage, or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed. The word "sewer" includes sewers and drains of every description, except drains to which the word "drain" applies.'

Drains are generally earthenware pipes properly glazed inside; sewers may be either of earthenware or

built of brick. Drains vary in size from four to six inches in diameter for closets and sinks, increasing to fifteen inches for the larger house drains leading into the public or street sewer. Sewers built of brick should be well cemented, elliptical, or egged-shaped, with the smaller end downwards. They should be large enough to allow a man to creep along them, and they should never be allowed to be more than two-thirds full. 'In Paris the main sewers are made with paths on each side, just above the stream; a tramway runs on one side which carries a machine, which can at once clear the bottom of the sewer; the entrance to each house drain is marked by a porcelain plate bearing a number; the owner of the house pays a small sum—three francs—annually to have his house drain kept clean.'

Fall and Velocity of the Current.—One foot in forty-eight for house drains, for street sewers one in from fifty to three hundred feet, the fall depending somewhat on the size of the drain. The velocity for house drains should be about 220 feet per minute, and for the street drains about 100 feet per minute (Parkes).

Manholes.—These should be placed at convenient distances, and fitted with ventilating chambers filled with charcoal.

Obstruction to Sewers.—This may be due to—

a. Improper levels used.

b. Imperfection in the laying and making of the sewers.

c. Impediments at mouth of sewer from—

1. Accumulation of mud, excreta, etc.
2. Backward pressure of sewage due to tides and wind.
3. Want of proper supply of water to flush the sewers periodically.

Composition of Sewage from sample obtained from the southern outfall Crossness.

Total solid matter in solution, .	Mineral, 67·2	Organic, 13·3	= 80·50
Total solid matter in suspension, .	Mineral, 8·8	Organic, 10·2	= 19·00
Chlorine—chiefly as common salt, ...			21·39
Nitrogen existing as ammonia, ...			3·15
Organic nitrogen, ...			0·70

Proposed plans for the removal of sewage—

1. Dry Method. 2. The Wet Method.

Under this is included the various plans for the disinfection of sewage and sewage irrigation.

1. *Dry Method.*

Adopted to a great extent in India, where the proper fall for the sewers cannot be obtained, and in places where there is either an insufficiency of water, or the water for many months of the year is frozen. Where this system is adopted, the excreta are passed into proper receptacles, which in some cases allow of the fluid portions draining away; in others, the solid and fluid portions are collected and emptied daily on the land, adding greatly to its fertility. Closets fitted with pans containing dry earth, on the plan suggested by the Rev. H. Moule, are now used in several parts of England, and are a vast improvement on the old and disgusting privy and cesspool. The quantity of earth required, Mr. Moule states, is about two hundredweight per head for twelve months, or about one and a quarter pound per head daily. In the year 1870 the earth-closet system was carried out most successfully in the villages of Halton and Beverley, near Tring. The earth is dried in iron pans over a fire, and then distributed to the villages, half a load being sufficient for a family of six for three months. The earth is dried and used twice, and then thrown upon the land.

2. *The Wet Method.*

This may be divided under three heads—

1. The emptying of the sewage into a neighbouring river or into the sea.

2. The addition of disinfectants and other substances to precipitate the solid matter, and then allowing the liquid portion to pass into a river or the sea as above.

3. The use of the sewage for the purposes of fertilization by irrigation. The means by which this is accomplished are as follow :—

a. By subterranean irrigation.

b. By underground pipes and hose-and-jet distribution.

c. Surface channels.

d. By submersion.

1. Of the disposal of sewage by the first plan all that can be said against it is, that it is a great waste of valuable manure, and that by it we give to the sea what ought to be placed on the land.

With regard to the second and third methods much discussion has arisen.

Against the second it is urged, that the solid part left after precipitation possesses little, if any, fertilizing properties.

Against the third the following objections have been raised :—

a. That the exhalations from sewage farms may become a source of disease—enteric fever, etc.

b. That the vegetable growth of such farms, even when the process of irrigation is carefully conducted, is exceedingly rank, and may give rise to disease in man and animals. Dr. Spencer Cobbold's theory is, that the sewage brings down the eggs of the tapeworm and disease germs, and that during the course of the sewage over the land some of the germs adhere to the growing plants. That when an animal eats such sewage produce, the ova of the tapeworm are

developed, and cysts are formed in the flesh of the animals, which, if eaten by man in an imperfectly cooked state, the cysts then develope into mature tapeworms. His theory has, however, not been corroborated, for no cysts were found in the flesh of an ox fed on sewage-grown grass for the purpose of experiment.

c. That there is frequently a difficulty in obtaining sufficient land for the complete and effectual disposal of the sewage of large towns. This difficulty is increased in proportion to the size of the town, for the required land may be large, and the price considerable. It must also be remembered, when irrigation is relied upon as a means of disposing of large volumes of sewage, *that the supply is continuous*, while the land is always in varying states to receive it, being in wet weather already saturated with water. The effect of this state of things is to convert the whole area of land used for irrigation into a malarious swamp. Another minor objection to sewage irrigation, but one which must not, however, be overlooked, is the possible contamination of the neighbouring water supply by filtration of the sewage through the earth.

Chemical Methods for Defecating Sewage.—Many plans have been proposed for the defecation and purification of sewage, which, though successful in a sanitary point of view, have proved commercial failures.

The following are the three best known :—

1. The lime process.
2. The phosphate of alumina process of Messrs. Forbes & Price.
3. The A B C process.

1. *The Lime Process.*—This process consists in the simple addition of a definite quantity of caustic lime, the amount added being in proportion to the strength of the sewage. This precipitates the whole of the suspended matter with a certain amount of the dis-

solved constituents of the sewage. A fair degree of purification is thus obtained, and the effluent water is tolerably clear; but the precipitate possesses no fertilizing properties, and is therefore of no value.

2. *Phosphate of Alumina Process.*—This process is a good one, but the materials used are too expensive to command success on a large scale. It consists in precipitating the sewage by the aid of phosphate of aluminia dissolved in sulphuric acid, and then adding caustic lime. The process was carried on at Tottenham for some time; but, owing to the difficulty experienced in obtaining the native phosphate of aluminia, the scheme has failed.

3. *The A B C Process.*—The precipitating agent in this scheme is a mixture of alum, blood, clay, and charcoal; hence the name. The sewage is mixed with a given quantity of the A B C mixture and allowed to settle in precipitating tanks; the clear liquid is drawn off, and the sediment is dried and sold as manure. The effluent water is very good, and may be allowed to flow into a stream without doing any harm, but the manure is of little value.

SCHOOLS, CHURCHES, AND THEATRES.

In schools, churches, and theatres a system of thorough ventilation is absolutely necessary; and in the case of theatres, care should be taken that the means of egress in case of fire is easy of access.

A proposal for ventilating the school-rooms of Boston has been presented to the Massachusetts State Board of Health by Mr. Martin, architect, by means of a ventilating shaft, the impure air being removed from the room through openings under the scholars,—fresh air, properly warmed, being admitted from the roof. Mr. Martin refers the injurious effects of bad ventilation not so much to the carbonic acid present in the air, as to 'the watery vapour and the

animal matter thrown off both by lungs and skin, which seems to putrefy almost immediately after being thrown into the air.'

CEMETERIES.

The disposal of the dead is a matter of considerable importance to the well-being of a community. The following methods have been adopted :—

1. Embalming.
2. Cremation.
3. Sea burial.
4. Land burial.

Cremation, in a sanitary point of view, is by far the best way of disposing of the dead, but public prejudice is against the proceeding. Sir Henry Thompson lately drew attention to this subject in an article on 'Cremation' in the *Contemporary Review;* but his advocacy was marred by his commercial views as to the value of the dust for agricultural purposes, at once disgusting and repulsive to most people. Sea burial can only be adopted in towns on the coast, as the expense would be too great when the body has to be carried any distance. Embalming is never likely to be adopted by modern nations.

Land burial, which, in a sanitary point of view, is the worst of all forms of burial, will most probably last the longest of any, till the public mind by degrees becomes tutored to an enlightened appreciation of the sanitary benefits of cremation.

Burial in the ground is open to the following objections :—

a. That the air over churchyards and cemeteries is charged with carbonic acid, ammonia, and an offensive putrid vapour. From the churchyards of London it has been stated that $2\frac{1}{2}$ millions of cubic feet of carbonic acid gas were given off yearly by 52,000 bodies buried in the yards.

b. That disturbance of these grounds gives rise to disease.

c. That wells and other sources of water supply are contaminated by impurities percolating through the soil.

The following remedies have been suggested :—

a. The removal of burying-grounds to some distance beyond the town.

b. Burying the body as deeply as possible.

c. The use of plants of quick growth and dense foliage, which purify the air by absorbing the organic substances and the carbonic acid.

QUARANTINE ESTABLISHMENTS.

These establishments were first appointed by the Venetians, the regulations being made about the year 1484.

The term is derived from the Italian *quaranta*, forty; forty days or six weeks being the time supposed to be required by those on board a ship sailing from an infected port to purify themselves and their baggage. The first regulations were instituted against the importation of the plague, which was generally supposed to have been introduced into Western Europe from the East. Most other countries have adopted more or less entirely the Venetian practice of detaining travellers from entering their country unless they can show a clean bill of health. The existing quarantine regulations are embodied in the 6 Geo. IV. c. 78, and the different Orders in Council issued under its authority. All Orders in Council with regard to quarantine are published in the *Gazette*; and this publication is deemed sufficient notice to all concerned, and no excuse of ignorance is admitted for any infringement of the regulations. All vessels are furnished with an abstract of the quarantine regulations.[1]

[1] See Beckman's *History of Inventions*, vol. ii. art. Quarantine.

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THE END.

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